SCIENCE ABSTRACTS.

Section A.—PHYSICS.

APRIL 1913.

GENERAL PHYSICS.

537. *Exponential Computer.* **L. Ross.** (Eng. News, 69. pp. 366–367, Feb. 20, 1913.)—An exponential computer has recently been devised by the author, which consists of a straight-line chart and a straight-edge, or, better, a fine hair-line drawn on a strip of transparent celluloid. This computer multiplies and divides, like an ordinary slide-rule, but in addition it gives at one setting any power, from 0 to infinity, or any root of any number; it will also, at one setting, multiply any number by any root or power of any other number. Trigonometric or any other special functions can be handled by labelling one line on the chart with a scale of those functions. Expressed algebraically, the computer will give at one setting the value of any unknown in the equation $n = mb^p$, or with two settings the value of any unknown in the equation $x = m^y b^p$. The computer is in the form of a rectangle, of which the left and right edges, labelled $m =$ *multiplier* and $b =$ *base* respectively, carry logarithmic scales, and they are drawn any convenient distance (L) apart. The vertical lines are drawn at distances from the left represented by $Lp/(p+1)$, where p is the power or exponent, indicated at the bottom. The base scale at the upper right corner is extended by folding it over the top marginal line. Diagonal lines are drawn from the bottom right-hand corner of the rectangle to intersect the left-hand side at the points corresponding to the values shown for m. It is easy to show that any straight line across the diagram cuts the vertical p-line at the diagonal $n = mb^p$. Hence, since the position of such a line is determined by two points, the third point, on the left (m) or right (b) scales, or at the intersection of a diagonal (n) with a vertical (p) line, will give the value of the unknown. The extended base (at the top, for $b = 13$ to $b = 10{,}000$) can only be used with $m = 1$. For any other value of m, first find b^p, then multiply this by m, using the $p = 1$ line for this last multiplication. A. W.

538. *Micromanometer.* **A. Henry.** (Comptes Rendus, 155. pp. 1078–1080, Nov. 25, 1912.)—The apparatus consists essentially of two cylindrical reservoirs of diam. 4·5 cm., connected by a horizontal tube at the bottom.

The liquid used is carbon tetrachloride, which is not acted on by air and is not inflammable; moreover its viscosity and surface tension are both small. A small air-bubble in the middle of the horizontal tube separates the liquid into two portions. The apparatus is extremely sensitive and will easily show a movement of the index bubble for a pressure variation of 1/200 mm. of water. Owing to surface-tension effects there was a slight variation of zero after the bubble had undergone large displacements, but the error due to this would not be as much as 1 per cent. A bubble about 1 cm. long seems to be the most suitable. Various uses are suggested for the manometer.

A. W.

539. *Measurement of Gas Densities at High Pressures.* **A. Occhialini.** (N. Cimento, 4. Ser. 6. pp. 426–441, Dec., 1912.)—An apparatus is described for the measurement of gas densities at high pressures, based on the theory, first enunciated by Gale, that if a small volume v of compressed gas is allowed to expand into a receiver having a large volume V, in such a way that the final pressure is slightly above that of the atmosphere, and may be measured, then the mass of the gas originally occupying volume v may be readily determined. Thus, if h is the initial pressure in V, and t the temperature, the total mass before expansion is given by $m + \mathrm{V}h/76(1 + at)$, and after expansion by $(\mathrm{V} + v)\mathrm{H}/76(1 + at)$, whence

$$m = (\mathrm{V} + v)\mathrm{H}/76(1 + at) - \mathrm{V}h/76(1 + at),$$

and hence, dividing by v, the density is calculated. The apparatus consists essentially of a steel compression chamber, the capacity of which may conveniently be from 3 to 10 cm.^{3}, an expansion chamber of glass, of about 900 cm.^{3} capacity, and a manometer.

W. H. Si.

540. *Theory of Elasticity.* **H. Lorenz.** (Phys. Zeitschr. 14. pp. 71–74, Jan. 15, 1913.)—The theory of elasticity gives for the displacements $\xi\ \eta\ \zeta$ of a material point under stress three partial differential equations of the second order, whose rigid integration has only been accomplished in isolated cases. W. Ritz gave approximate solutions from a series of functions of the co-ordinates $\mathrm{F}_1\mathrm{F}_2$; $\Phi_1\Phi_2$; $\Psi_1\Psi_2$ which fulfil the limiting conditions, the scheme being $\xi = a_1\mathrm{F}_1 + a_2\mathrm{F}_2 + \ldots$; $\eta = b_1\Phi_1 + b_2\Phi_2 + \ldots$; $\zeta = c_1\Psi_1 + c_2\Psi_2 + \ldots$, where $a_1a_2 \ldots b_1b_2 \ldots c_1c_2$ are statically indeterminate. If the internal work L_i and the external work L_a is calculated in this manner, their equality yields an equation of condition which connects the coefficients a, b, c. The author illustrates the process by applying it to the case of a beam fixed at one end and carrying a weight suspended from the other. He determines the coefficients $a_1, a_2 \ldots$ in such a manner that $\mathrm{L}_i - 2\mathrm{L}_a$ acquires a singular value in the case of elastic equilibrium. This was also arrived at by Ritz on variation considerations. It appears as a consequence of Castigliano's theorem concerning the work done in changing the shape of elastic systems.

E. E. F.

541. *Report on Shock Tests.* **G. Charpy.** (Rev. de Métallurgie, 9. pp. 1015–1025, Dec., 1912.)—In order to emphasise the importance of shock tests it is necessary to define the conditions under which the results of two distinct tests are comparable, and the extent to which the numerical results define the qualities determining the practical value of the materials. With regard to the conditions necessary to ensure comparability of two shock tests it is necessary to consider separately the shape and dimensions of the

test bar, the methods of calculating the results, and the apparatus and method of measurement employed. For small differences in size the resilience (specific work per cm.^{2} of the section at the point of fracture) of geometrically similar bars is practically constant for the same material. Independent tests by Bartel, Ehrensberger, and Charpy on 80 × 80-mm. and 10 × 10-mm. bars have shown that the resilience is always smaller on the small bars than on the large ones, and that the difference is always greater on tough materials than fragile materials. Unfortunately the conditions are not so simple in the case of shock-bending tests to rupture as in the case when deformation only is produced. There are two distinct effects in the former case: first, the work causing the general deformation, which is proportional to the cube of the linear dimensions; and secondly, the work absorbed in separating the two parts of the bar, which should be proportional to a power of the dimensions in the neighbourhood of the square. With regard to the machines used, it is recommended that a method of verifying the graduations should first be devised. Further research is necessary to settle all these points, and a collection of observations is requested giving the following information: Shape, nature, and use of the part; nature and treatment of the metal used in its manufacture; work done, compared with similar parts; circumstances under which breakage or deformation has been produced; sketch indicating the path of the fracture and the positions of the specimens taken, and a statement of the various tests made on the material as delivered during the process of manufacture and after treatment subsequent to the fracture, together with the conclusions drawn particularly from shock-bending tests on notched bars. An example of such a report is appended to the paper. F. C. A. H. L.

542. *Relation of Static Strength to Fatigue Strength under Fluctuations o, Load.* **P. Ludwik.** (Zeitschr. Vereines Deutsch. Ing. 57. pp. 209–213, Feb. 8, 1913.)—Every permanent set depends on the internal friction along two systems of cleavage planes. Tests show that the ratio λ : P of set to load increases, variously for different metals, with the initial set. Similarly, λ/P decreases with increasing speed of deformation, so that a series of load-deformation curves is obtained for various speeds, the lowest being that for zero velocity, *i.e.* infinite duration of test. If a load P which is $<$ U, the max. load attained on the lowest (or static) curve, be applied to a piece, then the strain increases at first rapidly, then more slowly, finally becoming stationary. The author's tests on tin wires show that if P $>$ U, the strain grows steadily to the value corresponding to U on the static curve, and then more slowly to failure. When load is applied at a steady rate up to P and is removed, the curve falls more or less steeply, according to the rapidity of unloading, till it intersects the static curve at a load P_0, when it falls to zero along the load ordinate. On being reloaded at the same rate the material yields when the load P_0 is again attained. Thus when P is repeatedly applied, each fluctuation gives rise to two sets in addition to the initial set, which tend to zero, if P $<$ U, in such a way that the total set is equal to that for the load P on the static curve. If P $>$ U, the cumulative sets decrease until the total reaches the set for max. load on the static curve, when they start increasing till failure occurs. With metals which show a sharply defined yield-point a period of 4 days' rest between unloading and reloading raises the new yield-point by as much as 18 % above the initial load, showing that the self-hardening after overstraining is a time-function. The author finds, however, that this effect is absent with metals such as copper and zinc, which show smooth stress-strain curves; these should therefore conform to the above theory and have a strength under fluctuating stress equal to the static strength. Owing to dynamic effects, to eccentric loading and to the well-known effect of irregularities in the surface of specimens and of want of homogeneity, the dynamic strength was expected to be less than the static, but not by 30 % as has been found. The author finds that ⅓-mm. soft well-annealed electrolytic-copper wires 1 m. long fail after 5 mins. under 4958 gm. load, after 2 hours under 4785 gm., and 90 hours under 4500 gm. Two such wires loaded with 3950 gm. failed after 14½ months at an ultimate strain of 20 %, whilst 3500 gm. had failed to cause fracture after 2 years, and the strain was then only 11 %. Thus the discrepancy between the dynamic strength and the static strength as determined in an ordinary tensile test is due to the true static strength being over 20 % less. E. J. S.

543. *Shock Tests on Notched Bars.* **C. Fremont.** (Rev. de Métallurgie, 9. pp. 1163–1166, Dec., 1912.)—The report to the 5th International Congress of the Assoc. for Testing Materials is criticised as regards the choice of apparatus, the dimensions of the test-bars, the shape of the notch and certain conditions of the test. It is suggested that the height of fall should be at least 4 m., or the impact velocity should be correspondingly great; the weight of the anvil should be 14 times the weight of the hammer, and a ready means of calibration should be provided. If suspected regions are not known they should be sought for by polishing, etching, and microscopic examination, and with the object of revealing the minimum of, rather than the average, quality, the test-bars should be as small as possible, say 35 × 10 × 8 mm. F. C. A. H. L.

544. *Tests of Nickel-Steel Riveted Joints.* (Univ. of Illinois, Bull. No. 49. Engineering, 94. pp. 763–764, Dec. 6, 1912. Abstract.)—Tests were made in pure tension of lap and butt joints of various types with and without fillers, or dead packings, made from nickel, chrome-nickel, and carbon steels. The former two were also tested in alternative tension and compression, for bending of rivets, deformation of joints and slip of plates. Test joints were 6½ in. to 7½ in. wide with from one to 18 rivets, but in no case were there more than two rivets in a line across the width. To detect bending of rivets, they were drilled axially ⅛ in. diam. A series of Stub's steel rods was used varying from ⅛ in. downwards, to gauge the curvature during testing, which could be estimated from the diam. of rod which would just pass. As a result of the tests it is stated that the shear resistance of the rivets is less if the plate material is harder than the rivets, and vice versa. Slip is greatly affected by workmanship. All joints show a definite "yield-point." Under alternating stress considerable slip occurs at low loads, but in these tests the ultimate strength is not appreciably less than in steady tension. As the number of alternations was small, the authors disclaim any suggestion that a large number of stress reversals would produce no fatigue. The "yield" under alternating stress does not appear to be lower. The ratio of yield to failure stress of a joint is about the same as that of the plate material. For joints designed with reference to ultimate strength, the use of special steels may be advantageous: but their use in designs for frictional grip of rivets is of little value. Roughly, the strengths of joints are as 100 for carbon steel to 109 for chrome-nickel-, to 116 for nickel-steel. The carbon steel was, however, at the disadvantage of having holes punched and not reamered, with pneumatically closed rivets, and of being of a specification inferior to that of best British practice. The cover plates were also overstressed relatively to strength. Curves are given of the properties of increasingly complex joints in the three steels. Slip results are somewhat erratic specially for carbon steel, which is inferior to Ni- and Cr-Ni-steel, the latter being slightly the best. The unevenness is probably due to varying rivet grip and holes being out of truth. Both special steels show an upward trend in the more complex joints due to the better grip of longer rivets. At yield all three metals behave very similarly, nickel- being slightly better than chrome-nickel- and carbon-steel not much inferior. There is a uniform falling-off of yield resistance with increasing complexity, attributed to increased bending of longer rivets and to less perfect load distribution, the carbon-steel plates also usually being overstressed. Although it is hard to discriminate with the special steels between the value of rigidity of material and that of excess plate section, it is stated conclusively that the former favours high rivet resistance by minimising local yielding in detail. For ultimate resistance all three steels lie close together, nickel leading, in spite of their widely varying physical properties. It is noticeable that fillers stopping at the ends of covers cause a pronounced reduction of "yield" strength. E. J. S.

545. *Ice Friction under Pressure.* **H. Morphy.** (Phil. Mag. 25. pp. 133–135, Jan., 1913.)—This investigation was undertaken at the suggestion of J. Joly, who thought it might be of interest in connection with his theory of skating, this theory being, as is well known, that skating is rendered possible by the formation of a film of water between skate and ice, owing to the melting of the latter under pressure. The experimental determinations consisted in the measurement of the coefficient of statical friction between the runners of a small sleigh, carrying a variable load, and the surface of ice kept at constant temperature. The angle of friction was found to remain constant until a certain stage of the loading, when it suddenly fell to about half its original value. It then remained constant for further increases in the load. The corresponding two constant values of the coefficient of friction are 0·36 ± 0·1 and 0·17 ± 0·01 respectively for the aluminium sleigh in use. E. H. B.

546. *Fixation of Units by Legislative Means.* **R. de Baillehache.** (Rev. Génerale des Sciences, Jan. 15, 1913.)—The French Minister of Commerce and Industry having asked the various commercial, industrial, and scientific communities whether the present would not be an opportune time to fix, by legislative means, new units, such as the units of force, heat, light, and electricity, the author reviews the whole question, mainly from the national standpoint and in anticipation of forthcoming legislation. In addition to the usual units of length, mass, etc., the term *Cop* is put forward for the absolute unit of force on the decimal metric system. *Unit of force.*—The cop (abbr. for Copernicus) is that force which, acting on a mass of 1 kg., gives it an acceleration of 1 m. per sec. per sec. In published works the additional unit of force, the hectogramme, could be used. A force of 1 hectogramme = 0·980665 cop. Conversely 1 cop = 1·01972 hectogramme (mass). *Unit of work.*—While the absolute unit of work or energy is the joule, in transactions the additional unit, the hectogramme-metre could be used (1 hectogramme-metre = 0·980665 joule). *Unit of power.*—The absolute unit is the watt: this is the power generated by the displacement of a force of 1 cop at a speed of 1 m. per sec. As additional unit the poncelet could be used (1 poncelet = 1 kw. approx., more exactly 0·980665 kw., and is 4/3 of the older *cheval-vapeur* of 75 kilogramme-metres). *Unit of pressure.*—The absolute unit is the decabarye [decabar] (or tor, abbr. for Toricelli), and is the pressure exerted by the force of 1 cop uniformly distributed of a surface of 1 metre-square. The submultiple ($\frac{1}{10}$) of this is called the *barye* (= pressure of column of Hg of 750·05 mm. height at 0° C.). In industrial work, the "atmosphere" to be retained (1 atmo. = wt. of column of Hg 735·5 mm. in height at 0° C. = 98066·5 decabaryes). The normal standard atmospheric pressure is = 101321·1 decabaryes or about 1 million *baryes.* The author then proceeds to discuss the definitions of the various units, and concludes with the hope that future legislation will recognise the beauty and harmony of the M.K.S. (metre, kilogramme, second) system. L. H. W.

547. *Quaternionic Relativity.* **L. Silberstein.** (Phil. Mag. 25. pp. 135–144, Jan., 1913.)—This is the second communication on this subject [see Abstract No. 1155 (1912)]. This work commences by the introduction of a simplified form of the force-quarternion, which is $P_e = -\frac{1}{2}G[D]F$. The D placed here between G and F denotes a differential operator which is intended to act both forward and backward. It is afterwards shown that the one operator G[ ]F furnishes (i) *the force-quaternion,* (ii) *the corresponding stress,* and (iii) *the flux and density of energy,* according as the vacant place in the brackets is filled by D, by a simple vector, or by a simple scalar respectively. Thus, the operator in question, does all the offices of Minkowski's matrix S of 4 × 4 elements or Sommerfield's and Laue's "world-tensor." E. H. B.

548. *Non-Newtonian Mechanics.* **R. C. Tolman.** (Phil. Mag. 25. pp. 150–157, Jan., 1913.)—In this article it is shown that the Einstein transformation equations, and the other principles of non-Newtonian mechanics, lead to a number of further transformation equations for acceleration, mass, rate of change of mass, and force. The transformation equations of force are identical with those chosen by Planck. Two applications of the transformation equations are given. By combining them with Coulomb's law, the expected equations are derived for the force with which an electric charge in uniform motion acts on any other charge, and by combining them with Newton's laws of gravitation a new expression is derived for the gravitational force with which a particle in uniform motion acts on another particle. [See Abstracts Nos. 357 and 784 (1912).] E. H. B.

549. *Longitudinal and Transverse Mass.* **J. Ishiwara.** (Phys. Zeitschr. 14. pp. 26–29, Jan. 1, 1913.)—P. Frank [Abstract No. 29 (1913)] derived from purely dynamic and energetic premises formulæ for the longitudinal and transverse mass of a system which exactly agree with those of the relativity theory. He did this by adding to Abraham's relations a modification of Duhem's axiom, that "the work required to impart to a body of velocity *u* an additional velocity *v* in a direction normal to *u* is equal to the work required to impart to it a velocity *v* from rest." Frank makes the ratio of the two amounts of work equal to the ratio of the mass at velocity *u* to the mass at rest. The author regards this process as too artificial, and prefers another dynamical principle based upon the invariance of "action" with respect to space-time transformations. In a system at rest a body is given a small displacement by a known force. The work is measured both in the system at rest and in a moving system. The difference is equal to the work on a body moving in the system at rest with a velocity equal to the relative velocity of

the two systems. This leads to the conclusion that there is no change of mass with velocity unless space and time are given a new interpretation different from the classical one. The electron has probably a constant mass, and the observations of Kaufmann, Bucherer, and Hupka may have to be interpreted in a different way. E. E. F.

550. *Oblique Impact of Two Confined Streams of Water.* **A. H. Gibson.** (Roy. Soc. Edinburgh, Trans. 48. 28. pp. 799–811, 1913.)—Describes experiments on the loss of energy at oblique impact of two confined water jets. The following conclusions are drawn from the experimental results:—(1) The friction loss per foot run of such rectangular passages as were used, with sections varying from 1 in. × 0·5 in. to 2·5 in. × 0·5 in., is given by

$$h = 0{\cdot}0086\, v^{1{\cdot}88}/2gm^{1{\cdot}20} = 0{\cdot}000056\, v^{1{\cdot}88}/m^{1{\cdot}20}\ \text{ft.},$$

where m = (area)/(perimeter) in foot-units. (2) The loss at plain elbows of uniform rectangular section is given by $\mathrm{F}v^2/2g$ ft., where $\mathrm{F} = 0{\cdot}0000676\,\theta^{2{\cdot}17}$, θ being the angle of deviation of the elbow in degrees. (3) Where the elbow is formed by the junction of one pipe with a second, and so has a dead end facing the final direction of flow, the loss is increased. In such a case

$$\mathrm{F} = [(m-1)^2/m^2 + 0{\cdot}00046\,\theta^{1{\cdot}8}/m],$$

where m is the ratio of the areas of the outlet and inlet legs of the elbow. (4) The loss L at impact of two confined streams, only one of which suffers deviation, is given by $\mathrm{L} = av_1^2/2g + bv_2^2/2g$ ft.-lbs. per lb. of the impinging jet (2), *i.e.* the jet which is deviated on impact. The values of the coefficients a and b are tabulated and graphed. (5) The formula

$$\mathrm{L} = [(v_2 \sin\theta)^2 + (v_2 \cos\theta - v_1)^2]/2g\ \text{ft.}$$

gives results which, except in one or two particular cases, are totally unreliable. (6) Where the volumes Q_1 and Q_2 to be discharged by the two streams are known, and where the ratio m of their areas may be modified as required, the value of m for minimum loss is given by

$$m = 1 + 2\theta/100 + \sqrt{\theta}\,\mathrm{Q}_1/11{\cdot}4\,\mathrm{Q}_2.$$

(7) Where both streams are similar and each suffers the same deviation θ, the area of the combined streams being equal to the combined areas of the impinging streams, the loss is substantially the same as in an elbow of uniform section and with the same angle of deviation. A. W.

551. *The Unsinkability of Modern Sea-going Ships.* **Flamm.** (Engineering, 95. pp. 215–217, Feb. 4, 1913.)—Refers to the rules embodied in the printed Bulkhead Curves, and points out the danger involved in the fact that these curves do not take any account of the *stability* of the vessel when she is open to the sea. The argument is illustrated by diagrams of stability which are given for the s.s. *George Washington* (North German Lloyd), *Mauretania*, and *Titanic.* L. H. W.

552. *Stability of Flow of Incompressible Viscous Fluid.* **A. H. Gibson.** (Phil. Mag. 25. pp. 81–84, Jan., 1913.)—As a result of experiment Osborne Reynolds concluded that the conditions tending to stability of flow, *i.e.* to stream-line as opposed to sinuous flow, of an incompressible viscous fluid are: (1) Free (exposed to air) surfaces. (2) Converging boundaries. (3) Curvilinear motion with the velocity greatest at the outside of the curve. (4) An

increase in viscosity. (5) A diminution in density. From an examination of the equations of motion he also showed that conditions (4) and (5) might be predicted from theoretical considerations. As regards conclusion (3), recent experiments by the author indicate that for increased stability in curvilinear motion the greatest velocity should be at the inside, not at the outside of the curve, and in the present paper it is shown that this, as well as the truth of conclusions (1) and (2), may also be inferred from the general equations of motion. A. W.

553. *Energy Law for Fluids.* **D. Bánki.** (Zeitschr. Vereines Deutsch. Ing. 57. pp. 17–25, Jan. 4, 1913.)—Describes an experimental investigation of the law of flow for liquids streaming through curved tubes. A. W.

554. *Transverse Vibrations of a Rod of Varying Cross-section.* **P. F. Ward.** (Phil. Mag. 25. pp. 85–106, Jan., 1913.)—An extension of some results given by Kirchhoff. L. H. W.

555. *Motion of Viscous Liquid due to Uniform and Periodic Motion Maintained over a Segment of an Infinite Plane Boundary.* **W. J. Harrison.** (Roy. Soc., Proc. Ser. A. 88. pp. 13–23, Jan. 29, 1913.)—Theoretical.

556. *Screw Propeller Design.* **C. W. Dyson.** (Amer. Soc. of Naval Engineers, Journ. Engineer, 114. pp. 215–216, Aug. 30, 1912.)

557. *Variations in the General Atmospheric Circulation in Temperate Latitudes.* **A. Defant.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 379–586, March, 1912.)—An investigation of the variations of daily amounts of rainfall over large areas in temperate latitudes in both hemispheres shows that they occur in several oscillations of definite periods travelling in an east-west direction. Four such waves can be distinguished, of which the lengths correspond respectively to the whole circuit of the earth in an east-west direction, and to the half, third, and fourth parts of that circuit respectively. The velocity of propagation of all the waves is nearly constant and amounts to 14·5° per day on the year's average, so that each wave completes the circuit of the earth in about 25 days. The velocity is greater in the northern hemisphere than in the southern, greater in winter than in summer, and greater over the continents than over the oceans. The amplitude of the yearly variation shows local differences. All the observed variations in rainfall may be explained as consequences of the regular progression of corresponding waves of pressure. Rainfall is an index of the intensity of vertical motion upwards, but the latter is closely related with downward and horizontal motions and is therefore connected with the general circulation. R. C.

558. *High Tropical Winds.* **W. van Bemmelen.** (Nature, 90. pp. 250–251, Oct. 31, 1912.)—Observations of pilot balloons in Batavia confirm the existence of a high *westerly* wind above the trades and anti-trades, immediately below the persistent easterly winds which are peculiar to the tropics, and which carried the dust from the Krakatoa eruption of 1883 many times round the earth at a level of about 30 km. The order of the currents is the following: (1) Shallow local breeze; (2) SE. trade wind, to 3 km.; (3) NE. anti-trade, to 17 km.; (4) upper SE. trade wind, to 18 km.; (5) high westerly wind, to 23 km.; (6) easterly Krakatoa wind, to at least 30 km. The velocities of the currents numbered (2), (3), (5), and (6) are about 5, 16, 12, and 35 m./sec. respectively. R. C.

559. *Investigations of Föhn.* **H. v. Ficker.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 829–873, May, 1912.)—The results of three balloon voyages from Innsbruck made during föhn winds, and the records from registering balloons liberated from Munich gave the following results. Before föhn commences at the surface it blows aloft from SE. over a cold surface layer, which covers mountains and valleys to an equal depth, and is usually also SE. in direction, although that is governed principally by the trend of the valleys. The boundary between the two currents is marked by a layer of strato-cumulus cloud. The direction of föhn itself when it appears at the surface is nearly independent of the contour of the land. It is, however, slightly deflected in the valleys, while it rises on the windward sides and descends on the lee sides of the mountains. Föhn is dissipated either by an invasion of cold air from the NW. below the upper SE. wind, or by a gradual accumulation of cold air at the surface. An adiabatic temperature gradient is found only along a definite stream-line: in a vertical direction the gradient is less than the adiabatic, but greater than the normal amount for the place and season. Change of wind direction with height is normal in the föhn itself, passing from SE. to SW. as the height increases. In the lower layer the normal surface wind at the commencement of föhn is SE., while at the end it is W. or SW. The change to the SE. of the föhn current is usually a discontinuous one. R. C.

560. *Temperature and Humidity in the Atmosphere on Occasions of Föhn.* **H. v. Ficker.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 1225–1243, July, 1912.) —In a previous paper [see preceding Abstract] the author showed that föhn blows across the valleys at Innsbruck which trend east and west, descends the lee sides and ascends the windward sides of the mountains. The stream-lines near the ground thus follow roughly the surface contour, but they become crowded together over the summits of mountains and they open out over the valleys, until at some unknown height above the tops of the mountains they are undisturbed by the surface contour and are horizontal. Since the air is descending on the whole there are no condensation effects, and the potential temperature along a stream-line is constant, the actual temperature changing adiabatically. Again, because the vertical temperature gradient is smaller over the mountains than in the valleys, a fact which follows from the thermodynamics of the föhn, it follows that as one passes away from the mountains on the lee side at any given height the temperature rises, while relative humidity falls. R. C.

561. *The Diurnal Variation of Wind Force at the Summit of Ben Nevis.* **J. v. Hann.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 185–220, Feb., 1912.) Estimates on the Beaufort scale of wind force on Ben Nevis were made hourly during the time the observatory was open. The author deals mainly with 10 years' observations, 1884–1887 and 1898–1903. A Robinson anemometer was installed at the summit, but on account of the low temperature combined with the abundant precipitation it could not be used in winter and it was frequently put out of action in summer. From a comparison of 15 months' corresponding results of recorded and estimated winds, the conclusion is drawn that the factor for converting the estimates to true velocities in miles per hour is nearly constant throughout the scale, and for statistical purposes it may be taken to be 7·72. The unusual conditions at the summit are sufficient to account for this result, which is different from that deduced for sea-level stations, where the factor increases with increasing wind

velocity. At Ben Nevis, however, there is a well-marked diurnal period in the factor, for which no explanation is forthcoming; it being least, 7·48 at 8 p.m., and greatest, 8·11 at 8 a.m. As regards the daily variation of wind force, the maximum occurs with great regularity between 1 and 2 a.m. The minimum is more variable; from Nov. to March it occurs at 4 p.m., in April, May, and June at 5 p.m., in July, Aug., and Sept. at from 2 p.m. to 3 p.m. The variation of the maximum from the mean is greater than that of the minimum, consequently the wind remains below the mean value for more than half the day. The seasonal variation of the mean difference between daily maxima and minima shows two maxima, in Jan. and July, and two minima, in March and Nov. In spite of the high latitude, the high degree of cloudiness, and the lack of winter sunshine, the diurnal variation is thus very well marked in winter. The author finds it difficult to account for the variation, which is not dissimilar in character from that on European mountain peaks, by means of the usual explanation, which requires strong diurnal convection currents. He suggests that the cause of diurnal variations of wind on mountain peaks calls for further inquiry. An investigation of the frequency of gales shows that there is a well-marked double period in its diurnal variation, with maxima at midnight and 9 a.m. and minima at 5 a.m. and 3 p.m. This result is similar to those found for Vienna and for the German coast. [For the observations from which the author's results are derived see Abstract No. 1462 (1911).] R. C.

562. *The Geographical Distribution of Monthly Variations of Pressure.* **W. Köppen.** (Meteorolog. Zeitschr. 29. pp. 501–511, Nov., 1912.)—For the investigation of non-periodic variations of pressure, the author uses the mean difference between the highest and lowest barometer readings in each month [see Abstract No. 828 (1912)]. Plotting these on maps of the world, one for each month, and drawing lines through places where the variation is the same, curves are obtained which are called "isokatanabars" after Lockyer's "isanakatabars" which represent a different measure of the fluctuations. Previous results of the author are combined with recent work of Brockmöller [see Abstract No. 1633 (1912)], and two charts of Isokatanabars are shown, one for winter (Dec., Jan., and Feb. in the northern hemisphere, combined with June, July, and Aug. in the southern) and one for summer. The greatest variations occur at about latitude 60° in both hemispheres and the least at the Equator. The variations are greater (up to 45 mm.) in winter than in summer (up to 33 mm.). The lines run nearly parallel to the lines of latitude, and the amount of the variation is related to variations of temperature along the parallels as well as to the general fall of temperature from the Equator to the pole. R. C.

563. *Diurnal Variation of Temperature at Tor on the Red Sea.* (Cairo Scientific Journal, May, 1912. Meteorolog. Zeitschr. 29. pp. 479–480, Oct., 1912. Abstract.)—Tor is situated on the Gulf of Suez on the western coast of the Sinai peninsula. It shows in June an unusual diurnal temperature variation with a *maximum* of 29·1° C. at 8 p.m. At 8 a.m. and 2 p.m. the values are respectively 25·4° C. and 28·7° C. The relative humidity for the same month shows the inverse variation, *i.e.* the *minimum* occurs at 8 p.m. At Minia, on the Nile, in the same latitude, the variations are normal. The cause is to be found in the diurnal variation of wind direction. In the morning it is from W. and NW. and is therefore a cool and moist sea breeze, but in the

afternoon and night it veers to NE. and E., and flows down from the mountains, bringing with it the high temperature of the land accentuated by the dynamical warming due to the descent. R. C.

564. *Suggestions for Frost Protection.* **K. F. Kellerman.** (Washington Acad. Sci., Journ. 3. pp. 53–55, Feb. 4, 1913.)—The author puts forward a proposal to prevent the occurrence of frost in orchards by spraying hot water into the air around the trees. Calculations are made of the quantity of hot water which would be required to raise the temperature certain specified amounts. Apart from loss of heat by convection, etc., it is found that about 90 gallons of water at 90° C. would be required to raise the temperature of a layer of air 26 ft. deep covering one acre from $-1°$ C. to the freezing-point if the humidity was initially 80 per cent. It is suggested that the fog which would be produced would further help to maintain the temperature above freezing by hindering the loss of heat by radiation. J. S. Di.

565. *Atmospheric Disturbances and Solar Radiation.* **C. Dorno.** (Meteorolog. Zeitschr. 29. pp. 580–584, Dec., 1912.)—The variations of heat radiation, brightness of solar disc, and ultra-violet radiation during a period of atmospheric disturbance in Oct., 1912, are given for comparison. C. P. B.

566. *Diurnal Variations of Atmospheric Pressure.* **W. J. Humphreys.** (Mount Weather Observatory, Bull. 5. 2. pp. 132–159, 1912.)—The author discusses the 24-hour and 12-hour components into which the normal diurnal variation of the barometer can be analysed, and investigates the effect of every agent that may be supposed to produce the observed phenomena. The 12-hour variation, which is much more definite and regular than the 24-hour variation, passes through two maxima at 10 a.m. and 10 p.m. local time, and through two minima at 4 a.m. and 4 p.m. The author regards the morning maximum and the afternoon minimum as being *forced* by the convection effects associated with solar radiation, which interfere with the normal course of east-west winds and thus affect the pressure; while the night maximum and the morning minimum are secondary disturbances caused by the joint action of the forced primaries through the agency of the free period of oscillation of the atmosphere of nearly 12 hours. The causes which prevent the variation from becoming larger are (1) friction, and (2) the probable slight discrepancy between the free period of the atmosphere and 12 hours exactly. R. C.

567. *Evaporation on the Nile near Khartum.* **R. Türstig.** (Meteorolog. Zeitschr. 29. pp. 454–462, Oct., 1912.)—An instrument is described for measuring the amount of evaporation, and the results of observations made from 22 March to 16 April, 1912, are described. The chief results are: The mean temperature of the water is lower than that of the air, the difference varying from 6·3° C. in summer to 1·7° C. in winter. The variations of air-temperature are unconnected with variations of evaporation. Evaporation by day is about twice as intense as evaporation by night. It is greater in the morning than in the afternoon. The max. rate occurs between 8 and 11 a.m., being about 1·0 mm. per hour, while the minimum in the night is less than 0·3 mm. There is no connection between evaporation and relative humidity, nor between evaporation and wind direction. The force of the wind is almost entirely responsible for variations in the amount of

evaporation, and for the period considered it is found that 0·6 mm. and 1·0 mm. of water are respectively evaporated in each hour when the wind velocity is 14 and 24 km. per hour, while intermediate amounts are associated with intermediate velocities. The average daily amount of evaporation was 18·8 mm., the max. and minimum values being respectively 24·7 mm. and 6·8 mm. R. C.

568. *Atmospheric Studies.* **J. W. Sandström.** (Mount Weather Observatory, Bull. 5. 2. pp. 83–131, 1912.)—In this memoir the author discusses some general propositions on the changes of condition of atmospheric air, on the energy transformations taking place in the atmosphere, and on the vortex motions of the atmosphere. R. C.

569. *The Variograph, its Records and their Application to some Questions in the Theory of Thunderstorms.* **W. Schmidt.** (Meteorolog. Zeitschr. 29. pp. 406–414, Sept., 1912.)—[See Abstract No. 507 (1910).] The variograph is an instrument which records automatically the rate at which atmospheric pressure is changing. Ordinary coal-gas is passed through an apparatus for regulating its pressure, and is lighted at the end of the outflow tube. Between the pressure regulator and the lighted end the tube is connected with a large vessel full of gas. When the pressure remains constant the flame burns steadily, but when the pressure falls, gas escapes through the tube from the large vessel, until the pressure inside it is equal to that of the atmosphere outside; and consequently the gas flame increases in size. Conversely when pressure rises the flame diminishes in size. The variations of the flame are recorded by placing in it a bimetallic thermometer, which records on a rotating drum through a series of multiplying levers in the usual way. The record of the thermometer is thus a record of the rate of pressure-change, for the greater the rate of change the greater is the variation of the size of the flame from the normal. The author prefers the curves of rate of pressure-change (variograms) to the records of an ordinary barograph, because upon the variograms the quicker variations are more pronounced than the slower, and small changes in a steady rise or fall of pressure are shown much more clearly than on the barogram. Pressure waves of 8 to 10 minutes' period are found nearly always to precede local thunderstorms, and the waves are so regular that a stable arrangement of the layers of air is indicated, quite contrary to the generally accepted theory. The fact that thunderstorms are not observed with föhn in which an adiabatic state must prevail, is in favour of the deduction. The variograms for line squalls and thunderstorms show very clearly the sudden rise of pressure that is so characteristic on the barograms. In general the variogram shows a fairly sudden rise followed by a more gradual fall back again to the zero line, indicating that pressure first increases at a rapidly increasing rate, and then increases at a gradually diminishing rate. The wind and rain come on at the commencement of the second stage, *i.e.* at the end of the rapid increase in pressure. The curves for line squalls and thunderstorms are so much alike that it is concluded that the latter are usually due to the flooding of cold air in the same way as the former. The fact that the specific humidity is as frequently higher as lower after a thunderstorm shows that fresh air must have taken the place of that observed before the storm. Thunderstorms are probably developed as a result of instability, but they are propagated in air that is essentially in stable equilibrium. These conclusions apply primarily to the summer heat thunderstorms as observed in Austria. R. C.

570. *Graphical Method for Observation of the Motion of the Clouds with the Perspective Nephoscope.* **A. Lo Surdo.** (N. Cimento, 4. Ser. 6. pp. 442–458, Dec., 1912.)—A modification of the Marangoni nephoscope [Abstract No. 11 (1903)] is described, which permits of the determination of the ratios between the horizontal and vertical components of the velocity of a cloud and its height, and of the azimuth and inclination. W. H. Si.

571. *Photoelectric Eclipse Measurements.* **J. Elster** and **H. Geitel.** (Phys. Zeitschr. 13. pp. 852–855, Sept. 15, 1912.)—During the 1900 solar eclipse, observed in Spain, it was found that the recovery of the full sunlight was more rapid than its extinction. This was tested at Wolfenbüttel during the total eclipse of April 17, 1912, by means of the potassium photoelectric photometer devised by the authors [Abstract No. 1884 (1912)]. The photoelectric current observed ranged from 4·56 microamps. for full sunlight filtered through a blue Jena uviol glass to 0·6 microamp. at the maximum phase. The recovery shows practically a symmetry with the waning phase, but there is a lag of the light amounting to 1 or 2 per cent. This may be due to a slight diminution of the transparency of the sky produced by the moon's shadow. There is is no evidence of a more rapid recovery. Some figures obtained at Palma, Majorca, in 1905, are added for comparison. E. E. F.

572. *Spectrographic Observations of Sun's Rotation.* **J. B. Hubrecht.** (Roy. Astronom. Soc., M.N. 72. pp. 5–27, Nov., 1912.)—The investigation formed the Cambridge portion of the co-operative scheme for determination of the sun's rotation, as decided at the Solar Union Conference at Mount Wilson in 1910 [Abstracts Nos. 802 (1909); 1436 (1911)]. Observations were made with the Littrow spectroscope, having a Michelson grating, a dispersion of 1·13 mm. per Å. being obtained with the fourth order. A series of preliminary observations were taken to determine the stability of the instrument, and then a series of plates throughout the year at the solar equator, giving the means of detecting variations in the equatorial velocity at a time of sun-spot minimum. The region allotted to Cambridge extended from λ4300 to λ4500, and a table of the lines considered is given, with the deduced equatorial velocity for each selected line. From the summary of velocities for the lines due to the different elements it is concluded that there is no strong evidence of systematic variation dependent on the assigned chemical origins of the lines. Advantage was taken of the fine weather during May and June, 1911, to obtain a series of observations all round the sun in addition to the Equator plates, the records being made so as to discriminate between the rotational velocities of the two hemispheres. This is done by taking comparisons from points 90° apart, instead of the usual method employing points 180° apart. Consistent evidence is obtained of a difference of about 0·186 km. per sec. The average equatorial velocity during 1911 is given as 1·86 km. per sec. C. P. B.

573. *Photographs of Partial Solar Eclipse at Greenwich, April* 17, 1912. (Roy. Astronom. Soc., M.N. 73. pp. 41–46, Nov., 1912. From Royal Observatory, Greenwich.)—Owing to this eclipse being of unusually large magnitude, it was arranged to obtain a series of photographs of the various phases with the Thomson photoheliograph of 9-in. aperature, with the object of determining the relative positions of the sun and moon, and the resulting correction to the moon's place. Fifteen photographs were obtained, the times of exposure being automatically recorded on the chronograph by

contact-pieces on the shutter plate. Details of the method of reduction are given, and a table showing the apparent errors in the tabulated places of the moon for each of the fifteen plates. C. P. B.

574. *Spectrum of Nova Geminorum* (1912). **F. J. M. Stratton.** (Roy. Astronom. Soc., M.N. 73. p. 72, Dec., 1912.)—Photographs of the later spectrum of the Nova were obtained at Cambridge on Dec. 6 and 12, 1912. The characteristic bands were those of hydrogen and the nebula lines at λ4364, 5007. The hydrogen bands were about 25 Å. wide. Mention is made of faint bands with centre near λ4800, a region generally vacant in the spectrum of novæ during their later stages. C. P. B.

575. *Similarity of Variations of S Persei and of Sun-spots.* **H. H. Turner.** (Roy. Astronom. Soc., M.N. 73. pp. 116–124, Dec., 1912.)—In former papers a comparison has been made of the sun-spot curve with the light curves of long-period variables, chiefly with respect to the periods less than the main period of 11⅛ years. Also Schuster has shown that in the case of sun-spots other periodicities, chiefly submultiples of a chief period of 33⅜ years, are associated. The present note deals with the examination of the long-period variables for such associated periodicities. The most promising results have been obtained in the case of S Persei. Nothing is found in the variations of this star corresponding to the 13·5-year period in sun-spots. There is a period of 665 days in S Persei with no sensible 6·75-year period in sun-spots, and the question is discussed whether the sun-spot periods of 8·17, 11·12, 13·5 years correspond with the S Persei periods of 665, 845, and 1073 days. C. P. B.

576. *Algol-variable R. R. Draconis.* **F. H. Seares.** (Astrophys. Journ. 36. pp. 368–384, Dec., 1912. Contribution from the Mount Wilson Solar Observatory, No. 64. Science, 37. pp. 33–34, Jan. 3, 1913.)—Observations made with a 7½-in. equatorial of the variations of this interesting Algol variable gave a period of 2·831079 days. Normally the star is a little brighter than the tenth magnitude, but during minimum it becomes too faint for the above instrument, and observations have therefore been continued with the 60-in. reflector at Mount Wilson by means of photographic registration. From these the minimum brightness is given at 13·53. From the curves showing the comparison between photographic and visual measurements, it may be noted that for two magnitudes below normal light the photographic variation is closely represented by the visual light-curve. From that point on, the photographic variation is greater than the visual, the divergence amounting to about three-tenths of a magnitude in an interval of a magnitude and a half. For the greater part of the curve the variation is rapid, and the last portion of the change requires but 20 minutes. The data obtained indicate that the eclipse is total, showing the darker star to be the brighter of the two. C. P. B.

577. *Parallax of Weisse*$_1$ 592. **E. Kinberg.** (Ark. för Mat., Astron. och Fysik, Stockholm, 8. 15. pp. 1–25, 1912.)—From measurements on plates taken during the period Oct. 18, 1907, to March 22, 1908, the parallax of this star is determined to be $\pi = +0{\cdot}186'' \pm 0{\cdot}060''$. Several values given by other investigators are referred to for comparison. C. P. B.

LIGHT.

578. *Electrically-heated Microscope Slide.* **F. G. Cottrell.** (Amer. Chem. Soc., Journ. 34. pp. 1328–1332, Oct., 1912.)—The apparatus was designed for the study of liquid crystals, but is convenient wherever a rapid adjustment of temperature under the microscope is desired. The essential feature is a uniform film of Pt deposited over the glass slide which is to carry the object, so thinly as not to seriously reduce its transparency, but still forming a continuous conductor for the electric current. By connecting this film in series with a rheostat to an ordinary 110- or 220-volt lighting circuit, any temperature from that of the room to nearly the melting-point of glass may be rapidly established. To minimise the danger of cracking, the glass slips should be small, say ⅓ by 1 in., and thin (0·6 to 0·8 mm.). The thin Pt coating is deposited by means of the discharge (Zerstaubung) from a Pt kathode in high vacuum. The ends of the slip are coated more thickly, to serve as terminals, either by applying gold paint, or by dipping them in a collodion solution containing a small amount of gold or platinum chloride. In either case, the slide should be heated over a Bunsen burner until the organic matter is completely burnt out. Non-conducting materials may be examined by placing them directly upon the platinised surface; with electrolytes a slip of thin cover glass may be interposed. A. E.

579. *Bispherical Reflecting Condenser for Ultramicroscopy.* **H. Siedentopf.** (Ann. d. Physik, 39. 6. pp. 1175–1184, Dec. 23, 1912.)—Discusses first anastigmatic reflection at two spherical surfaces, with special reference to a Zeiss bispherical cardioid condenser. A geometrical construction for anastigmatic reflection at two spherical surfaces is given, also a mathematical treatment of the formation of the image at points not on the axis of the system. A. W.

580. *Diffraction Images.* **J. W. Gordon.** (Phys. Soc., Proc. 24. pp. 422–448, Oct., 1912.)—The author gives the theory of diffraction patterns in a comprehensive form and by means of an elementary mode of treatment. The simplification consists essentially in substituting as the surface of resolution the envelope which forms the boundary of an aplanatic pencil in place of the wave-front which occupies its aperture. The general doctrine is developed in 17 propositions, and the bearings of the theory are illustrated by reference to the optical problems connected with the formation of a spectrum by a diffraction grating; also by reference to the effect of stopping out the centre of an object glass, and again by the problem presented by the ultimate limit of resolving power in optical instruments. A. W.

581. *Optical Properties of the Ions in Water.* **A. Heydweiller.** (Phys. Zeitschr. 13. pp. 1010–1012; Discussion, pp. 1012–1013, Nov. 1, 1912. Paper read before the 84. Naturforscherversamml., Münster, Sept., 1912.)—The refractive power of a dissolved salt is almost independent of its ionisation, and is approximately equal to that of the solid salt. The dispersion in the visible spectrum is also almost independent of ionisation; it is nearly equal for salts with the same anion, but varies considerably if the kathion is kept constant and the nature of the anion is varied. In the ultra-violet region the

dispersion both of the ionised and un-ionised solutions can be expressed by a formula of the Sellmeier type; this is best used to express the *ratio* of the refractive power of the solution to that of pure water. The characteristic wave-lengths of the free vibrations are given as 168 $\mu\mu$ for the Cl ion, 185 $\mu\mu$ for the Br ion, 230 $\mu\mu$ for the I ion, as contrasted with 161 $\mu\mu$ for solid KCl, and 156 $\mu\mu$ for solid NaCl. In the *discussion*, **Rubens** pointed out that the free periods in the far ultra-violet depend on the oscillations of electrons, which are independent of the nature of the molecule, and may be expected to be the same whether the atoms are in the form of ions or of molecules. But the deep infra-red vibrations depend on the oscillations of the whole mass of the molecule, and might be expected to show large variations as a result of electrolytic dissociation. Actually, a strong salt solution reflects the "reststrahlen" of salt no better than pure water. T. M. L.

582. *Measurement of Colour.* **A. C. Jolley** and **A. J. Bull.** (Phys. Soc., Proc. 24. pp. 417–421, Oct., 1912.)—A paper dealing with a series of experiments made with a view to ascertaining the form of optical instrument most suitable for the measurement of colour. All forms of colour-mixing arrangements in which intermittent light is required were omitted from the experiments, since intermittent illumination was found to produce a somewhat rapid fatigue of the eye, and hence the readings soon became of little value. The methods adopted are based upon the Young-Helmholtz hypothesis. It was found that any colour could be imitated by the admixture, in suitable quantities, of the lights of three suitably chosen narrow regions of the spectrum. The only three with which all shades could be matched were: for the blue primary a narrow region from 0·463 to 0·466 μ, for the green the region from 0·529 to 0·535 μ, and for the red from 0·634 to 0·644 μ. Instead of adding these coloured lights broader primaries may be subtracted from the white light by the selective absorption of suitably chosen dyes, but in this case the difficulty of expression becomes a serious one, owing to the impossibility of securing dyes which absorb one primary region and transmit the remainder of the white light in equal proportions. Diagrams of the different forms of apparatus used are given; for details see original paper. A. W.

583. *Measurement of Spectrograms with Cylindrical Lens.* **J. B. Hubrecht.** (Roy. Astronom. Soc., M.N. 72. pp. 28–31, Nov., 1912.)—To obviate the effect of grain in the photographic plate, when measuring spectrograms under high power with a micrometer, a cylindrical lens is placed between the eyepiece and the eye. This makes the appearance of the lines more homogeneous, and enables the bisections to be made with greater certainty. C. P. B.

584. *Primary Standard of Light.* **H. E. Ives.** (Astrophys. Journ. 36. pp. 321–329, Nov., 1912.)—The author suggests a standard of light based on 1 watt radiation of max. luminous efficiency. This appears to be located near 0·546 μ, the green line in the mercury spectrum. The definition of unit luminous flux would be as follows:—"The unit of luminous flux is the flux from a source radiating energy of max. luminous efficiency at the rate of 1 watt." With light of the prescribed character as much as 800 lumens per watt might be obtained. In applying such a standard special methods are necessary to meet the difficulties introduced by heterochromatic photometry. But the author believes that a standard method of measurement, based on the use of the flicker photometer under certain specified conditions, and the

application of the luminosity curve of the normal eye so as to avoid personal errors, might be contrived. [See also Abstracts Nos. 393A and 288B (1913).] J. S. D.

585. *Helium Gas Standard of Light.* **P. G. Nutting.** (Bureau of Standards, Bull. 8. pp. 487–494, Nov. 1, 1912.)—Particulars have been given of some tests on tubes containing helium with a view to their being used as standards of light [see Abstract No. 661 (1908)]. It was then found that small differences in thickness in the bore of the capillary tubes used introduced errors and more uniform tubes, which were also fairly free from striations, have since been obtained. Details of the photometric tests to which these tubes were subjected are given. The mean deviation in candle-power per cm. length of tube is found to be 1·15 per cent., and the max. deviation in any tube 3 per cent. The chief improvement to be sought in the next series of tubes to be made is complete freedom from striations. J. S. D.

586. *Modern Microscopical Optics with Special Reference to Fluorite Objectives.* **C. Metz.** (Nature, 90. pp. 603–607, Jan. 30, 1913.)

587. *Theory of Monochromators of Great Light Intensity.* **G. J. Elias.** (Archives Musée Teyler, 1. Ser. 3. pp. 29–42, 1912.)—[See Abstract No. 859 (1911).]

588. *Photo-spectrography with Concave Gratings.* **C. P. Butler.** (Photographic Journ. 52. pp. 357–363; Discussion, pp. 363–364, Dec., 1912.)

589. *Recent Advances in the Measurement of Light and Illumination.* **J. S. Dow** and **V. H. Mackinney.** (Phys. Soc., Proc. 24. pp. 405–415; Discussion, pp. 415–416, Oct., 1912.)

590. *Central Aberration in Compound Lenses. Relation between Central Aberration aud Astigmatism at Edge of Field.* **H. Violette.** (Journ. de Physique, 3. Ser. 5. pp. 46–54, Jan., 1913.)

591. *First Steps in Telephotography.* **E. Marriage.** (Photographic Journ. 53. pp. 55–59; Discussion, pp. 59–62, Feb., 1913.)

592. *The Halo in the Ricefield and the Spectre of the Brocken.* **[Miss] A. Everett.** (Nature, 90. pp. 570–571, Jan. 23, 1913.)—Discusses Richarz's communication [Abstract No. 1832 (1912)], and calls attention to a remarkable distortion of the solar limb, due to refraction, observed by the writer near sunset, in 1908. L. H. W.

593. *Magneto-optical Researches.* **O. M. Corbino.** (N. Cimento, 4. Ser. 6. pp. 415–425, Dec., 1912.)—Experiments are described on the rotatory polarisation produced by the vapours of Na, Cd, Cu, and Zn, when subjected to the action of a magnetic field. For the first metal, a sodium flame was employed, and a rotation observed, but with the other three metals, which were vaporised by means of the electric spark, negative results were obtained, and the relation between absence of magnetic rotation and anomalous dispersion is discussed. A magneto-mechanical theory of light is suggested, which, however, experiments have failed to support. W. H. Si.

594. *Emission, Absorption, and Intensity Distribution of Spectral Lines.* **F. Reiche.** (Deutsch. Phys. Gesell., Verh. 15. 1. pp. 3–21, Jan. 15, 1913.)—A mathematical treatment of the subject, dealing with isolated narrow lines. A formula is derived for the intensity distribution (E_0) of a narrow spectral line, which gives symmetrical distribution about the centre of the line. The essential parameters of the curve are the damping, and the mean velocity of the emission centres. Special forms of intensity distribution depend on a parameter b, which is directly proportional to the damping and inversely proportional to the velocity of the emission-centres. If b is large, then we get "dispersion" distribution; if b is small, we get, at not too great distances from the middle of the line, Rayleigh's distribution. In the case of metal vapours in flames, the damping within wide limits depends only on the number of the flame-gas molecules per unit volume. With electrically excited gases in Geissler tubes the damping is proportional to the pressure. For infinitely thin layers and "dispersion" distribution, the half-width, to a first approximation, is given by two terms, the first of which is directly proportional to the pressure, the second being inversely proportional to the pressure. The dependence on the temperature is complicated. With Rayleigh's distribution, the half-width, to a first approximation, is a linear function of the pressure, the first part of the function being independent of the pressure and proportional to the square root of the absolute temperature. For infinitely thin layers the form of the intensity distribution curve is identical for emission and absorption lines. The same is true for layers of finite thickness. With dispersion distribution, the lines are considerably broadened for finite layers when the product of the density of the emission-centres and the thickness of the layer increases. With Rayleigh's distribution, this broadening is only small. The ratio of emission- and absorbing-power, E/A, within a narrow simple spectral line is a constant, independent of the damping and of the thickness of the layer. If the line radiation is a temperature radiation, as may be the case for metal vapours in the Bunsen flame, the value of E/A follows Planck's radiation law. Experimental evidence is adduced in support of the above conclusions. A. W.

595. *Photography of Absorption Spectra.* **T. R. Merton.** (Chem. Soc., Journ. 103. pp. 124–127, Jan., 1913.)—Gives a summary of the objections to the older photographic method (Hartley and Huntingdon's) of investigating absorption spectra. Measurements with the spectrophotometer [see Abstracts Nos. 38 and 1335 (1912)] can be made to give accurate quantitative results, but considerable practice is needed to give concordant results, and the probable error of the observations varies with the wave-length of the light used. The following method has been devised, which provides a simple and accurate method of obtaining extinction curves. A series of strips was photographed through a neutral Sanger-Shepherd plate of carefully standardised extinction, and between these a series of spectrum strips was obtained, using different thicknesses of the absorbing substance. By choosing a suitable time of exposure the points of equal extinction can be made to occur in each pair of strips at the density best suited for comparison. Light from a Nernst lamp, after passing through a water tank to remove heat rays, was rendered approximately parallel by means of a collimating lens, and then reflected twice (at 45° incidence) from mirrors M_1 and M_2, finally being focussed on the slit of a Hilger wave-length spectroscope, a photographic shutter being placed just in front of the slit. A Zeiss variable absorption cell was placed between the mirrors M_1, M_2. The thickness of the absorbing layer in this cell can be

accurately measured by means of a screw adjustment. In conducting the experiment, the cell was filled with the pure solvent, and the standardised plate laid on it. Strips 1, 4, 7, 10, and 13 were exposed. The plate was removed, and the cell filled with the solution to be investigated. Strips 2, 3, 5, 6, 8, 9, 11, and 12 were now exposed through various thicknesses of solution. Hence the necessary data for plotting a quantitative extinction curve are obtained. The method offers very little practical difficulty; the time taken in the measurement is little longer than with the method of Hartley, and quantitative results can be obtained without the use of costly apparatus. A. W.

596. *Series in Spectra of Tin and Antimony.* **T. van Lohuizen.** (Zeitschr. wiss. Phot. 11. pp. 397–414, Feb., 1913.)—A continuation of the author's previous work. Using the formula previously given [Abstract No. 1698 (1912)] a number of series are shown to exist of the type called by the author "translation series," in the spectra of Sn and Sb. A. W.

597. *Band Spectra of Various Gases.* **F. Burger** and **J. Koenigsberger.** (Phys. Zeitschr. 13. pp. 1198–1199, Dec. 15, 1912.)—Gives first a discussion of the hypotheses advanced with reference to band spectra by Stark and by Küpferer and Koenigsberger [see Abstracts Nos. 1087 (1908); 1027 (1912)]. Experiments are also described which tend to confirm the authors' hypotheses. It is shown that with bromine and NO_2 no ionisation due to absorption of light can be detected, and that the carriers of the band spectrum and fluorescence in the visible spectrum cannot be free ions or electrons. Hence it is concluded that reversible chemical dissociation is not connected with ionisation, as would be the case if Stark's hypotheses were correct. A. W.

598. *Series Systems in Spectra of Zinc, Cadmium, and Mercury.* **J. Stark.** (Ann. d. Physik, 39. 6. pp. 1612–1616, Dec. 23, 1912.)—In a previous paper Paschen has given a number of series in the spectra of Zn, Cd, and Hg [see Abstract No. 1486 (1911)]. In that paper, among other things, he arranged the Hg line 2536·72 with the lines 4078·05, 2857·07, and 2564·14 in a new combination series. Stark shows in the present paper that the lines 4078 and 2536 cannot possibly belong to the same series. Observations made up to the present show that lines of the same series have intensities of the same order, are found in the same light sources, broaden in a similar manner, and so on. Now, the line 2536 is given well in the flame, but not the line 4078; in the positive part of the arc at very low pressures the line 2536 is far the most intense line of the whole region 6000–2000, the line 4078 having an intensity compared with it of not more than 1/50. Observations on the Zeeman-effect, the Doppler-effect in the canal rays, and on the Zn and Cd lines all lead to the same conclusion. A. W.

599. *Ultra-violet Band Spectrum of Oxygen.* **W. Steubing.** (Ann. d. Physik, 39. 6. pp. 1408–1430, Dec. 23, 1912.)—Describes research upon the effect of different gases, of varying current and gas pressure conditions on the production of the first ultra-violet band spectrum of oxygen. It is found that in pure dry gases, which contain neither free nor chemically combined oxygen, the first ultra-violet band spectrum of oxygen can be produced under no conditions, whether the pressure is greater than atmospheric or the lowest possible. This band spectrum, on the contrary, appears intensely in the purest oxygen, thoroughly dried, if care is taken that neither hydrogen nor carburetted hydrogen are present. The spectrum also appears when the gas under investigation contains oxygen either simply mixed, or chemically combined, though the greater the spectral sensibility of the gas, the less intense is the oxygen spectrum; the proportion of oxygen present and the gas pressure also have an effect. With higher pressures and temperatures the band spectrum becomes clearer and more intense. A. W.

600. *Doppler-effect of Canal Rays.* **H. Wilsar.** (Ann. d. Physik, 39. 6. pp. 1251–1312, Dec. 23, 1912.)—A continuation of the author's previous work [see Abstract No. 194 (1912)]. Wien's method was used to investigate the effects in hydrogen, oxygen, and nitrogen. The following results were obtained:—(1) The lines of the hydrogen spectrum for which Dufour has found a Zeeman-effect show no Zeeman-effect in the canal-ray spectrum. (2) Principal series lines of hydrogen were not found in the canal rays. (3) All the spark lines of oxygen appearing in the canal rays show a Doppler-effect of the same magnitude (in agreement with Paschen's observations) and have therefore a common carrier. (4) For the series lines of oxygen Wilsar could find (in opposition to Stark's observations) no Doppler-effect. (5) The carriers of a single oxygen band cannot persist in the kathode fall of potential, but do persist in the penetrating canal rays of a force-free space. (6) The nitrogen bands in the canal rays from the negative pole have (in agreement with Hermann) no Doppler-effect; the carriers of these bands persist in electric fields. (7) Single lines of nitrogen have shown the Doppler-effect. There must exist for these lines at least two different carriers, since the effect is observed with different magnitudes for different lines. (8) The magnitude of the Doppler-effect does not, for H, O, and N, vary as $\sqrt{V}$, but reaches a limit for a certain potential characteristic for each gas. (9) While the carriers of hydrogen in the canal rays possess a single charge, the corresponding carriers for oxygen and nitrogen have multiple charges. (10) A magnetic field has quite a similar influence on the Doppler-effect in oxygen-canal rays to that for hydrogen. (11) The canal rays of hydrogen are not appreciably retarded by passage through a gas; the particles with small velocities are therefore more strongly absorbed than those with greater velocities. (12) Hydrogen canal rays (especially those with small velocities) are reflected both from glass (as Hermann has found), and also from a metal (Al) surface. (13) The "retrograde rays" exist in the whole discharge chamber, and are similar, as regards velocity and absorption in the surrounding medium, to the normal canal rays. (14) The carriers of the displaced line originate from the kathode fall of potential; they pass through the surrounding gas without undergoing loss of velocity or imparting velocity to other particles. The stationary particles of the surrounding medium acquire no velocity due to the impact of the moving particles, but are rendered luminous and are the carriers of the stationary line. (15) Most gases can be rendered luminous by the canal rays of other gases. (16) Mercury vapour is rendered strongly luminous by all canal rays, but is either totally unable to give rise to the displaced line in the radiation of other gases, or else can do so to but a very small extent. A. W.

601. *Intensity Distribution in Canal-ray Spectrum.* **J. Stark.** (Ann. d. Physik, 39. 6. pp. 1185–1200, Dec. 23, 1912.)—A discussion of the subject based on the experimental results of the author, Wilsar, Fulcher, and others [Abstracts Nos. 194, 856, 1365 (1912)]. If I_v is the intensity of the displaced line of the canal rays of velocity v, n_v the specific number, i_v the current strength of

these rays in the canal-ray beam, k_v proportional to the mean intensity of the individual particles, then $I_v = k_v n_v = k_v i_v / ev$. According to this equation the intensity of emission of the displaced line, with k_v constant and the current strength i_v also constant, decreases as the velocity of the canal rays passing the field of view increases. It also appears that the relative intensity of the displaced line increases with increased velocity of the canal rays for decreased and for constant gas pressure. A. W.

602. *Theory of the Zeeman-effect observed in any Direction.* **H. A. Lorentz.** (Archives Musée Teyler, 1. Ser. 3. pp. 1–24, 1912.)—[See Abstract No. 767 (1911).]

603. *Magnetic Rotation and Inverse Zeeman-effect in Mercury Vapour.* **H. Starke** and **J. Herweg.** (Phys. Zeitschr. 14. pp. 1–5, Jan. 1, 1913.)—Righi's experiment, in which an electromagnet with perforated pole-pieces, between which a sodium flame burns, produces a yellow luminosity in a beam transmitted through crossed nicols as soon as the field is turned on, is usually interpreted in terms of Macaluso and Corbino's observation of a great anomalous rotation of the plane of polarisation in the neighbourhood of the sodium line, a rotation which has also been observed in the cases of potassium, lithium, and hydrogen [see Abstract No. 1355 (1912)]. The authors also observed it in the blue Sr line, both blue Cs lines, and very strongly in the green Tl line. They used a quartz mercury lamp to find whether the whole of this effect is explicable on the lines indicated by Macaluso and Corbino, and found that there is, besides, a true "Righi effect" within the absorption lines themselves. This, however, is only observed in the green Hg line and its satellites, not in the yellow. All the doublets of the green line and its satellites became brighter, but remained perfectly sharp. When the nicols are not quite crossed there is a continuous spectrum with a fine self-reversal line at 5461, which darkens on turning on the field, the dark satellites appearing at the same time. An echelon grating was used. E. E. F.

604. *Specular Reflection of X-Rays.* **W. L. Bragg.** (Nature, 90. p. 410, Dec. 12, 1912.)—It has been shown by Laue, Friedrich, and Knipping that the diffraction patterns which they obtain with X-rays and crystals can be explained by assuming the existence of very short electromagnetic waves in the radiations from an X-ray bulb, with a wave-length of the order 10^{-9} cm. The spots of the pattern represent interference maxima of waves diffracted by the regularly arranged atoms of the crystal. If this is so, these waves ought to be regularly reflected by a surface which has a sufficiently good polish, the irregularities being small compared with the length 10^{-9} cm. Such surfaces are provided by the cleavage planes of a crystal, and the author has therefore tried mica, which has a very distinct cleavage plane. A narrow pencil of X-rays, obtained by means of a series of stops, was allowed to fall at an angle of incidence of 80° on a slip of mica about 1 mm. thick. A photographic plate set behind the mica slip showed, when developed, a well-marked reflected spot as well as one formed by the incident rays traversing the mica and support. Variation of the angle of incidence left no doubt that the laws of reflection were obeyed. By bending the mica into an arc the reflected rays could be brought to a line focus. An exposure of only a few minutes sufficed to show the effect. Slips of mica $\frac{1}{10}$ mm. thick were found to give as strong a reflection as an infinite thickness, yet the effect is almost certainly not a surface one. Further experiments are in progress. E. M.

605. *Distribution and Quality of Secondary Röntgen Radiation from Carbon.* **H. Pealing.** (Phil. Mag. 24, pp. 765–783, Nov., 1912.)—It is known that when X-rays fall on a radiator the distribution of the secondary radiation is not in accordance with simple scattering theory, the most notable feature being a large excess of radiation on the emergent side, especially with hard beams. According to theory, the amount (I_α) of X-radiation scattered in a direction α with the primary is given by $I_\alpha/I_{90} = (1 + \cos^2 \alpha)$. Barkla also showed that a "fluorescent" radiation is excited in the radiator when the penetrating power of the incident radiation exceeds a certain value, the ratio I_α/I_{90} for this fluorescent radiation being unity for all values of α. In the present experiments the distribution of secondary radiation from carbon is examined with incident beams of various penetrating powers, and the results show, (*a*) when the primary beam is soft the secondary beam consists of scattered radiation and an "extra" radiation which is softer than the primary. The proportion of extra radiation in the forward direction is much greater than in the other direction. (*b*) When the primary beam is hard the secondary beam consists of scattered radiation, a larger proportion of extra radiation than when the beam was soft, and hard fluorescent carbon radiation. E. M.

606. *Direct Production of Characteristic Röntgen Radiations by Kathode Particles.* **R. T. Beatty.** (Roy. Soc., Proc. Ser. A. 87. pp. 511–518, Dec. 18, 1912.)—It is well known that many elements can be stimulated to produce characteristic X-rays. So far, the only successful method of obtaining the characteristic rays has been to place the element in the path of a beam of X-rays, whereupon it becomes a secondary radiator; and if the exciting X-rays have the necessary penetrating power, the characteristic rays will make their appearance. Kaye [Abstract No. 457 (1909)] showed that if an element, say Cu, is made the antikathode in an X-ray bulb it becomes a source of intense radiation characteristic of Cu. An explanation of this result was suggested by Barkla and Sadler, the assumption being that the effect is indirectly produced by the kathode rays through the intermediate action of X-rays. Using later knowledge of the amount of energy transformed in such an operation, the author calculates that the amount of characteristic radiation found by Kaye is about ten times greater than can be accounted for by such an indirect action. Experiments described in the present paper show that the bulk of the effect is due to a direct transformation of the kathode rays into characteristic X-rays; that the small remainder is due to the indirect action suggested by Barkla and Sadler; and that the direct and indirect effects happen simultaneously as soon as the speed of the kathode rays exceeds a definite value. The method of experiment is to measure the relative amounts and penetrating properties of the X-radiations produced when pencils of kathode rays of definite velocity fall on antikathodes of (1) thick Cu, (2) thick Cu covered with Al-foil sufficient to stop the kathode rays but not X-rays, (3) thin Cu covered with the same Al-foil, (A) Al. The effects with the various antikathodes may be divided into three parts: (1) The "independent radiation" or radiation depending in quality on the speed of the kathode rays only, (2) characteristic radiations produced by the half of the independent X-radiation which enters into the copper, and (3) characteristic radiation produced directly by the kathode rays. The observations show that both the indirect (2) and the indirect (3) characteristic radiations disappear when the speed of the kathode rays is below $6{\cdot}25 \times 10^9$ cm. per sec. When the radiations appear the direct effect is

much greater than the indirect effect. Further, there is no diminution in the intensity of the independent radiation when the characteristic appears, showing that the atomic mechanisms which account for the two are not connected with each other. E. M.

607. *Similarity in Nature of X- and Primary γ-Rays.* **J. A. Gray.** (Roy. Soc., Proc. Ser. A. 87. pp. 489–501, Dec. 18, 1912.)—Previous experiments have shown that less radiation is excited in carbon by the β-rays of RaE than in radiators of higher atomic weight, and consequently it is convenient to cut off the β-rays of RaE by graphite when the properties of the primary γ-rays are under examination. In this way the author shows in the present experiments that the primary γ-rays from a preparation of Ra (D + E + F) contain a very soft constituent whose mass-absorption coefficient (about 8·8 in Al) shows that it is softer than some types of X-radiations. Absorption experiments were also made on the γ-rays excited in Pb by the β-rays of RaE, and the various results show that there is no fundamental difference in the absorption of X- and γ-rays. Further experiments showed that the primary γ-rays from RaE excite the characteristic X-radiations (series K) of silver, tin, barium, cerium, praseodymium and neodymium just as very penetrating X-rays would. Experiments in scattering showed that the primary γ-rays of RaE behave similarly, both qualitatively and quantitatively, to ordinary X-rays.
E. M.

608. *Number of α-Particles emitted by Thorium Emanation.* **J. Satterly.** (Le Radium, 9. pp. 484–487, Dec., 1912.)—There has recently been some discussion as to whether ThEm and ThA give 2 or 4 α-particles between them. The author has made experiments in which the relative ionisation of ThEm and ThA to that of thorium itself is compared with the relative ionisation of RaEm to radium. In both cases the emanations are removed from solutions and transferred to an emanation electroscope for measurement. From the results of the experiments, combined with Geiger's results for the ionisations produced by α-particles of different ranges, it is deduced that both ThEm and ThA give one α-particle per disintegrating atom.
E. M.

609. *Detection of a Single α-Particle.* **G. Hoffmann.** (Phys. Zeitschr. 13. pp. 1029–1033; Discussion, pp. 1033–1034, Nov. 1, 1912. Paper read before the 84. Naturforscherversamml., Münster, Sept., 1912.)—A review of the methods of detecting single α-particles is first given. A new sensitive electrometer is then described which has a low capacity, and can be made to give 10,000 divisions (mm.) per volt. The needle of the instrument constitutes the electrode, and this moves in a horizontal plane over two semicircular charged plates at potentials about + and — 25 volts respectively. E. M.

610. *Absorption of β-Rays.* **J. A. Gray.** (Roy. Soc., Proc. Ser. A. 87. pp. 487–489, Dec. 18, 1912.)—It is clear from various experiments that one of the main factors in the absorption of β-rays is the loss in velocity of β-rays in passing through matter. It follows that β-rays of a definite speed must have what may be called a maximum range, and also that an exponential law of absorption of β-rays can only be approximate. In the experiments described the absorption of the β-rays of RaE by paper was determined, using such thicknesses that the transmitted activity fell to less than 1/10000 of the initial

value with no absorption. The results show that the β-rays become more and more absorbable as absorption proceeds, *i.e.* the percentage transmission for the same thickness of paper decreases. E. M.

611. *Absorption of γ-Rays of Radium C.* **A. Brommer.** (Phys. Zeitschr. 13. pp. 1037–1040, Nov. 1, 1912. Paper read before the 84. Naturforscherversamml., Münster, Sept., 1912. Akad. Wiss. Wien., Ber. 121. 2a. pp. 1563–1583, Oct., 1912.)—In the experiments described special precaution was taken with regard to secondary radiation, which is now known to be an important factor in γ-ray measurements. Radium was used as source in amount varying from 40 to 680 mgm. $RaCl_2$, according to the part of absorption curve under investigation. The substances investigated were Pb and Hg, the values for the absorption coefficients found being 0·538 and 0·641 respectively over a very large range (up to 9 cm. Pb). These values are both 8 % larger than those of Soddy and Russell. E. M.

612. *Secondary γ-Rays excited by the β-Rays.* **F. Soddy.** (Phil. Mag. 24. p. 892, Dec., 1912.)—The author discusses the question of the origin of the γ-rays of UrX, which are considered to be primary rays and not secondary rays excited by the β-rays in the material of the vessel containing the UrX. The significance of the absorption coefficients of the γ-rays excited by β-rays in Chadwick's experiments [Abstract No. 431 (1913)] is also discussed. E. M.

613. *Delta Rays produced by β-Rays.* **N. Campbell.** (Phil. Mag. 24. pp. 783–788, Nov., 1912.)—In previous papers [see Abstract No. 689 (1912)] the author has shown that the quality of δ-rays emitted from solids under the action of α-rays is independent of the velocity of the α-rays and the nature of the solid. In the present paper the result is extended to δ-rays, which are shown to be produced by β-rays, thus proving that the properties of δ-rays are a function neither of the properties of the ionising rays nor of the material which they ionise, *i.e.* they are a function of the properties of some mechanism which is concerned in all ionisation. It appears from the experiments that the emission of δ-rays from a solid is equivalent to ionisation in a gas. The β-rays used in the experiments were not primary β-rays but β-rays excited in various substances by the incidence of Röntgen-rays. E. M.

614. *Recoil Atoms in Ionised Air.* **A. F. Kovarik.** (Phil. Mag. 24. pp. 722–727, Nov., 1912.)—When a radio-active atom disintegrates with the expulsion of an α-particle the recoil atom can be collected on a negatively charged plate. The present experiments were undertaken to ascertain the effect of strong ionisation on the transfer of the recoil atoms through air on to the negative plate. A plate activitated with actinium active deposit was used as source, the recoil of the atoms of the β-ray product AcD from the α-ray product AcC being studied. A plate at 115 volts was placed 12 mm. from the active plate, and the air between them ionised by the α-particles from an α-ray tube containing 10 millicuries of radium-emanation which produced about 10^{14} ions per sec. between the plates. With the source of ionisation in position the amount of AcD which reached the negative plate was only about 10 % of the amount in its absence. An investigation was also made showing that the number of recoil atoms drawn to the negative electrode increases as the p.d. between the plates is increased, the distance remaining constant; and also that the number increases as the distance is decreased,

the p.d. being constant. In these experiments no external ionising agent was employed. These results are naturally explained on the assumption that the recoil atoms only penetrate about $\frac{1}{10}$ mm. of air at N.T.P., when they become positive ions and lose their charge by recombination. Recoil experiments were also made, using plates of different polish for the active deposit plate. The number of recoil atoms collected was greater from surfaces of higher polish. During the experiments the periods of AcD and ThD were determined to be 4·71 and 3·07 minutes respectively. E. M.

615. *Radio-activity of Solutions of Uranium Salts.* **L. Michiels.** (Le Radium, 9. pp. 482–484, Dec., 1912.)—The author has studied the ionisation produced by solutions of uranium salts of different strengths, the ionisation being measured immediately above the surface. The activity was found proportional to the uranium (metal) content for the same volume of solution. The author suggests that such solutions can conveniently be used as standards for small activities. E. M.

616. *Active Deposit in the Atmosphere.* **K. W. F. Kohlrausch.** (Phys. Zeitschr. 13. pp. 1193–1198, Dec. 15, 1912.)—The author analyses the results of various observers, and concludes that enough active products are present in the atmosphere to account for natural ionisation. Thus the radium products on the average produce 1·56 pairs of ions per cm.^{3} per sec. The penetrating radiation from the earth appears to produce only a small effect in free air although the effect may be appreciable in a closed chamber owing to excited radiations in the walls. E. M.

617. *Relative Intensities of the Earth's Penetrating Radiation on Land and Sea.* **J. C. McLennan.** (Phil. Mag. 24. pp. 520–527, Oct., 1912. Paper read before the Roy. Soc. of Canada, May 17, 1912.)—There is a marked lack of agreement between different observers in regard to the number of ions produced per c.cm. by the natural penetrating radiation, and the daily variations in its intensity. The author has therefore made determinations in various localities using the same apparatus (zinc walls 0·5 mm.) which was hermetically sealed so that there could be no possibility of air containing active-emanation entering it during the course of the investigations. The results show that there is practically no difference in the number of ions produced inside a closed receiver when the point of observation was taken inside either a brick or a stone structure at points so far separated from each other as Cambridge (England), Bowland (Scotland), and Toronto (Canada). The mean value obtained under these conditions was 9 ions per c.cm. per sec. Further, the observations showed that the buildings themselves contribute on the average more than 1 ion per c.cm. per sec. Readings were taken every day on a vessel during a voyage across the Atlantic, and the mean value found was 6·0 ions per c.cm. per sec. The number directly over the water of Lake Ontario was 4·4. Diurnal variations at either Cambridge or Scotland were found to be either non-existent or less than 3%. E. M.

618. *Radiations Old and New.* **W. H. Bragg.** (Nature, 90. pp. 529–532, Jan. 9, and pp. 557–560, Jan. 16, 1913. Discourse delivered before the British Assoc. at Dundee.)

619. *Radio-activity of the Hot Springs of Iizaka, Iwasiro.* **D. Isitani** and **K. Manabe.** (Mathematico-Physical Soc., Tōkyō, Proc. 6. 20. pp. 291–293, Oct., 1912.)

HEAT.

620. *Electric Heater with Automatic Thermostat.* **A. L. Clark.** (Amer. Acad., Proc. 48. No. 14. pp. 559–605, Jan., 1913.)—Of the type in which the heating current is cut off or reduced by a rise in the mercury in a fine tube. Over a 30-minute test, the temperature ranged between 190·194° and 190·218° with cutting-off of the current and between 190·196° and 190·204° when the current was reduced but not broken. L. H. W.

621. *Micropyrometer.* **G. K. Burgess.** (Washington Acad. Sci., Journ. 3. pp. 7–10, Jan. 4, 1913. Phys. Zeitschr. 14. pp. 158–160, Feb. 15, 1913.)—The method described in Abstract No. 2063 (1907) has now been arranged to be carried out by one observer with a combined instrument. An incandescent filament is mounted within the eyepiece of the microscope, and from the current in this filament required to match the brightness of the specimen on the heated Pt-strip, the temperature is calculated. This method is an improvement on that originally used in which corrections had to be made for emissivities, and sometimes for the surface tension of specimens. The precision is mainly dependent on the character of melting of the specimen. With gold and nickel, which melt very sharply, a precision of 1° or 2° C. is obtainable. The use of the micropyrometer for the estimation of the temperature of incandescent surfaces simultaneously with their examination is suggested. F. R.

622. *Improved Joule Radiometer and its Applications.* **F. W. Jordan.** (Phys. Soc., Proc. 25. pp. 66–73 ; Discussion, p. 73, Dec., 1912. Electrician, 70. pp. 668–669, Jan. 10, 1913. Abstract.)—The radiometer devised by the author [Abstract No. 1223 (1911)] is improved by (1) replacing the badly conducting glass enclosure and cardboard partition by others made of brass and copper respectively, (2) replacing the variable magnetic control of the movement of the vane by the elastic control of a quartz fibre, (3) shaping the channels in which the vanes move so that the angular deflection of the vanes is proportional to the rate of evolution of heat, and (4) reducing the size of the apparatus, so that it may be placed within a concentric brass tube, thereby excluding all extraneous heat except that passing through apertures in its sides, and maintaining the various parts at a more uniform temperature. The sensibility of such an instrument is 0·52 mm. per microwatt, so that it may be used for measuring feeble oscillating currents, being almost as rapid as a Duddell milliammeter. It may be adapted for measuring the heat given out by small quantities of radium, the radiant heat being directed through a small rock-salt or fluorite window in the brass tube, on to a thin metal disc supported centrally by a fibre in one of the compartments, and the rate of absorption of heat being measured by Callendar's or Ångström's method. A compensation method is described by which a modification of this apparatus could be employed for measuring the Thomson-effect, the product of the mean compensating current and the mean resistance of the halves of the wire, divided by the temperature-difference between the centre of the thin wire and its thick leads, giving the Thomson coefficient. W. H. Si.

623. *Attainment of a Steady State when Heat diffuses along a Moving Cylinder.* **[Miss] A. Somers.** (Phys. Soc., Proc. 25. pp. 74–76 ; Discussion,

p. 76, Dec., 1912.)—It is shown that in Nettleton's method for the determination of thermal conductivities [Abstract No. 1112 (1910)] the time of attainment of a steady flow of heat along the column may be calculated from purely theoretical considerations, by solving the differential equation $K d^2\theta/dx^2 - v\rho s \, . \, d\theta/dx = \rho s \, . \, d\theta/dt$, which gives the temperature at any point within the column, and applying the fact that the flow of heat past any point in the cylinder is given by $K \, . \, d\theta/dx - v\rho s(\theta - \theta_0)$. The case of diffusion of a salt in solution up a tube may be treated in a similar manner.

W. H. Si.

624. *Method of finding the Conductivity for Heat.* **C. Niven** and **A. E. M. Geddes.** (Roy. Soc., Proc. Ser. A. 87. pp. 535–539, Dec. 13, 1912.)—This method of measuring the conductivity for heat of bad conductors is an extension of the method previously applied to substances mostly in powder or small grains. In the present method the body is used in flat layers and the heat is supplied by passing an electric current through a thin layer of Dutch leaf. Details of the arrangement and of the calculations are indicated. The following results ($\times 10^{-4}$ C.G.S. units) were obtained :—

Paper	3·27	Cork carpet	2·645
Plate glass	19·234	Linoleum	3·513
Norwegian pine	3·076	Leather	3·286
Mahogany	3·42	Fireclay brick	14·354
Ash	3·651	Polished clay tile	17·415
Canary pine	3·916	Vulcanite	4·210
Teak	3·974	Sulphur	6·151
Oak	5·011	Paraffin wax	6·649
Felt (green)	0·74–0·8		

T. H. P.

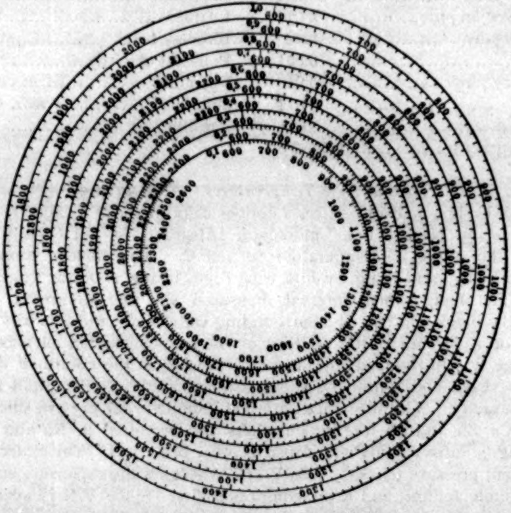
625. *Specific Heats at High Temperatures.* **A. Magnus.** (Phys. Zeitschr. 14. pp. 5–11, Jan. 1, 1913.)—Uses a copper calorimeter of a capacity 50 times that used by Nernst and Lindemann [Abstract No. 821 (1910)], so as to extend the range of temperature to 750° C. The hollow copper block weighed 22 kg., and hung by fine wire ropes inside a Dewar vessel 45 cm. deep. The temperature interval measured was the difference between that of the block and that of a surrounding water bath, and this was done by means of a thermoelectric battery of 50 iron-constantan elements. The substance was introduced into a conical boring in the centre of the block, and the vessel containing the substance was made of silver, and fitted the boring exactly. The substances studied included rock crystal, silica, oxides of Mg, Cu, Zn, and Pb, and the chlorides and bromides of Na and K. The results agree satisfactorily with those of other observers. The molecular heat at constant pressure $C_p = C_v + 9\alpha^2 V T/K$, where α is the expansion coefficient, V the atomic volume, and K the compressibility. Since V/K is nearly independent of the temperature, and α is proportional to C_p, we may put $C_p = C_v + C_p^2 TA$. The constant $A = 2·7 \times 10^{-5}$ (Nernst and Lindemann). This formula, applied to NaCl, gives for C_p the value 12·10 at 331° abs. and 13·40 at 664° C. The observed values are 12·10 and 13·33 respectively.

E. E. F.

626. *Theory of Specific Heat.* **M. Born** and **T. v. Kármán.** (Phys. Zeitschr. 14. pp. 15–19, Jan. 1, and pp. 65–71, Jan. 15, 1913.)—Instead of dealing with a continuum, as assumed by Debye [Abstract No. 1173 (1912)], the authors apply normal co-ordinates to a system of an infinite number

of degrees of freedom. A crystal is built up out of a Bravais space lattice of material points. The proper vibrations of these points are characterised by the phase differences ϕ, ψ, χ of every two molecules adjacent along the three axes respectively. Then it is proved quite generally that equal phase "districts" $\Delta\phi$, $\Delta\psi$, $\Delta\chi$ contain equal numbers of proper frequencies. This is put into another form thus: The number of proper-frequency triplets whose wave-length lies between λ and $\lambda + \Delta\lambda$ and whose wave normal lies in the solid angle $\Delta\infty$ is $Na^3 . 1/\lambda^3 . \Delta (1/\lambda) \Delta\infty$, where N is the number of molecules per mol and a is the molecular distance. The molecular frequencies include elastic vibrations. At low temperatures the specific heat is completely determined by the density and the elasticity. The atomic heat is, in fact $= 2{\cdot}74 + 10^{10} . m/\rho . (T/c_m)^3$ gm. cals./deg., where c_m is the velocity of sound, m the atomic weight, and ρ the density. This formula is confirmed in Al and Cu, but less well in Ag and Pb at very low temperatures. The authors finally show how their formula may be converted into Debye's formula for an isotropic body. [*Errata*, ibid. p. 176, Feb. 15, 1913.] E. E. F.

627. *Scale for Calculating Thermodynamic Temperatures.* **G. A. Shook.** (Phys. Zeitschr. 13. pp. 940–942, Oct. 1, 1912.)—The outermost scale gives the black-body temperatures from 600° to 2000°; the emissivity in this case = unity. The other circles give the corresponding thermodynamic temperatures of bodies having emissivities or absorption coefficients of 0·9, 0·8, . . . down to 0·1. L. H. W.



628. *Measurement of Temperature by Electrical Means.* **C. B. Thwing.** (Metallurgical and Chem. Engin. 11. pp. 86–88, Jan., 1913. Paper read before the Philadelphia Section of the Amer. Inst. Elect. Engin.)—A discussion of the methods of measuring temperature in different cases, describing the following types of instruments: (*a*) The simple thermo-couple; (*b*) the radiation pyrometer with thermo-couple; (*c*) the electric resistance pyrometer. For temperatures with a maximum range above 1500° C. the radiation type is the only one of the three which is available. Where the upper limit is 1500° C. the choice lies between the radiation and the Pt thermo-couple. Where the upper range is 1200° C. the chrome-nickel thermo-couple, the Pt thermo-couple, and the radiation type may all be used. For temperatures up to 1000° C. the iron-constantan thermo-couple comes first, but the Pt-resistance type is also available. For temperatures below 200° C. the iron-constantan thermo-couple and the nickel resistance may be used, but preferably the latter. In general when making temperature measurements a complex problem is being dealt with. J. J. S.

629. *Thermometric Lag.* **D. R. Harper.** (Bureau of Standards, Bull. 8. pp. 659–714, 1912.)—The author investigates the time lag taking place before a thermometer registers a constant reading when immersed in a warmer or cooler environment. The mercurial thermometer first receives consideration. For the ordinary or chemical form Newton's law of cooling provides an adequate equation, viz. $\partial\theta/\partial t = (u - \theta)/\lambda$, where u denotes bath temperature at instant t, θ the thermometer reading at the same instant, and λ a constant with respect to u, θ, or t, although not independent of the form of the thermometer, the medium surrounding the latter, conditions of stirring, etc. For some forms of thermometer—*e.g.* those having an air layer separating part of the bulb from the bath—the simple theory fails and the physical meaning of λ has to be investigated. From the fundamental equation $\partial\theta/\partial t = (u - \theta)/\lambda$, λ has the dimensions of time. Equations are established showing that if a thermometer has been immersed for a long time in a bath whose temperature is rising at a uniform rate, λ is the number of seconds (the lag) between the time when the bath attains any given temperature and when the thermometer indicates this temperature; also if a thermometer be plunged into a bath maintained at a constant temperature (the thermometer being initially at a different temperature), λ is the number of seconds in which the difference between the thermometer reading and the bath temperature is reduced to e^{-1} times its initial value. Special difficulties arise in the case of a falling meniscus due to sticking and even to separation of the mercury column; hence the pseudo λ so obtained may or may not be related to the temperature lag of the bulb and so is of little value. In precision thermometry, therefore, a falling temperature should be avoided, although where necessary the thermometer may be subjected to a series of rapid jars.

The author establishes the principal equations for the three cases of constant temperature, linear rise, and exponential change of temperature, and describes experimental methods for the determination of λ, illustrative values being given. The variation of λ with stirring is studied and a special apparatus described in which the velocity of flow past the thermometer bulb can be measured. For the determination of lag under conditions approximating to infinite velocity the thermometer was plunged into steam, when the heat supplied instantaneously as steam, condenses on the bulb and maintains its surface at the temperature of the steam, and the author concludes the behaviour of the thermometer to be not very different from what it might be if an infinite supply of heat could be instantaneously brought to the surface of the bulb. The determinations in unstirred water give a wide latitude of variation, probably due to differences in convection currents. On account of the great variation in the rate of change of lag with velocity a short investigation with kerosene oil was undertaken to see whether the same general form of curve would be found. As might be expected, the more viscous liquid gives a greater value of λ for a given velocity, although the results are similar. The lag of a thermometer in air next receives attention, since it is great enough to affect results quite appreciably. In the usual case proper corrections are difficult to make, as the thermometer is subject to draughts of widely different velocities, no single value of λ holding for more than a few moments. The lag of a Beckmann thermometer requires additional assumptions for theoretical treatment, since $\partial\theta/\partial t=(u-\theta)/\lambda$ does not hold. The reason is suggested by the form of the instrument, since the main bulb is like that of an ordinary instrument, while the large capillary between the bulb and the zero of the scale acts as a second smaller bulb and, being enclosed in a tube with an air layer between it and the bath, is quite slow to assume the bath temperature. The modified equations deduced are justified by experiment.

For electrical thermometers some kind of galvanometer is necessary for the two forms, thermometric and resistance, and the lag of the galvanometers has to be added to that of the thermometer. It appears that the galvanometer lag was the greater portion of the whole and frequently the only portion to consider. Resistance thermometers were found to be either very fast or very slow compared with mercurial. The Jaeger-Steinwehr method of lag computation receives thorough discussion. The lag of a thermocouple is, like that of a resistance thermometer, found to be principally a question of the form of mounting.

Thermometric lag in calorimetry then receives detailed consideration. An analytical proof is given of the fact that in an experiment where the same thermometer is used to determine temperatures in the "pre-period," the "middle period," and the "after period," the correction for lag in the middle period neutralises those in the pre and after periods. Corrections for lag in applied thermometry are given in some detail. In a bath at constant temperature no correction is to be made if the thermometer reading be taken after a sufficient interval. For a linear temperature-change of r units per second the correction to get the bath temperature is $+r\lambda$ units, while when the temperature-change is a continuous single-valued function of time the lag is $+\lambda\,.\,\partial\theta/\partial t$.

H. H. Ho.

630. *Dispersive Power of Platinum Black.* **C. Féry** and **M. Drecq.** (Comptes Rendus, 155. pp. 1239–1241, Dec. 9, 1912.)—The behaviour of platinum black when exposed to radiation was observed by direct measurement. A sheet of Pt 0·08 mm. thick was covered with platinum black by means of electrolysis on both faces and placed in front of an electric furnace. By means of a Féry pyrometric telescope connected with a galvanometer the radiation from the front and back of the plate was measured exactly. Thus the coefficient of absorption of platinum black was found to be 0·82, the temperature being between 1250° and 1432° abs. The result shows that platinum-black is not superior to lamp-black for absolute measurements of radiation. The temperature of the lamina was 13 deg. above that of the surrounding medium. The arrangement was used to make a new determination of the important coefficient a in Stefan's law, and hence of $\sigma=\pi a$. If an electric current is caused to pass through the Pt sheet, the furnace not being in action, it may be proved that the temperature of the sheet is the same on the two faces, which is a guarantee of the symmetry of the blackening. If then a curve is constructed of the deviations given by the telescope (energy radiated by the sheet) as a function of the electric power expended in this same sheet,

a straight line is obtained. There may then be referred to this straight line the power corresponding to anterior radiation W_a and the posterior W_p from the sheet when it is exposed to the electric furnace. The energy dissipated by the sheet is then $W = W_a/2 + W_p/2$, for the straight line standardised by the current gives the energy dissipated by the two faces of the sheet. But the energy given out by the furnace may be calculated, and is equivalent to that measured electrically. Thus $W = a T^4 (SS'/D^2)$, where a is the coefficient sought, T the absolute temperature of the furnace, S the surface of the sheet, S′ that of a screen of water placed in front of the furnace with an opening in its centre, and D the distance from this screen to the sheet. From the mean of the measurements thus made the value $a = 1{\cdot}97$ was found, and $\sigma = 6{\cdot}20 \times 10^{-12}$ (watts/cm.^{2} degree^{-4}). This value is a little lower than that obtained previously by the authors because the diffused heat does not follow Lambert's law, and the measurement of the energy in a single direction is insufficient to determine correctly the energy diffused by the anterior face. The measurement of the watts by the posterior face gives $\sigma = 5{\cdot}57$, which agrees with previous measurements made with plane receivers. J. J. S.

631. *Surface Combustion.* **J. R. Thompson.** (Phys. Zeitschr. 14. pp. 11–15, Jan. 1, 1913. From the English.)—Studies the mechanism of combination of hydrogen and oxygen in contact with hot surfaces. Mixtures of the gases in various proportions were introduced into a glass tube containing a heated Pt spiral, whose temperature was deduced from its resistance. An Al cylinder surrounding the spiral was connected with an electrometer, and served to determine the point at which ions were emitted by the hot Pt. This took place when its resistance was about 8·5 ohms, and increased very rapidly above 10 ohms. Mixtures of H and O containing from 3·6 to 26% H were then introduced under pressures of from 11 to 22 cm. Hg, and the wire was heated until the explosion took place. This was always at the temperature at which ions were discharged from the Pt. Its resistance ranged from 8·01 to 8·59 ohms. The explosion was thus dependent upon the emission of ions. There was no slow combustion Similar results were obtained on substituting a carbon filament for the Pt-wire. That the action is not a simple temperature effect was proved by making the Pt emit ions under the influence of X-rays. A suitable mixture was instantly exploded by turning the rays on to the metal. E. E. F.

632. *Energy-Content of Gases.* **W. Nernst.** (Phys. Zeitschr. 13. pp. 1064–1068; Discussion, pp. 1068–1069, Nov. 1, 1912. Paper read before the 84. Naturforscherversamml., Münster, Sept., 1912.)—Since the specific heats of solids are completely reduced to the author's formula, and liquids offer hitherto insuperable obstacles to a corresponding treatment, the next matter approaching settlement is that of the energy-content and specific heat of gases. Berthelot's equation of condition enables us to deduce molecular heats at constant pressure or volume from the critical pressures and temperatures. All data must be reduced to ideal gas conditions. As regards experimental methods, Pier and Bjerrum have carried the explosion method up to 3000° C. Eucken has devised a method for low temperatures based upon the fact that the capacity for heat of copper or steel vessels becomes very small in extreme cold. At ordinary temperatures the relation $C_v = 3R/2$ holds exactly for monatomic gases, but at low and high temperatures the relation is probably more complex. The relations $C^v = 5R/2$ for diatomic and $6R/2$ for polyatomic gases is reasonably verified. E. E. F

633. *Molecular Phenomena not in agreement with Thermodynamics.* **M. v. Smoluchowski.** (Phys. Zeitschr. 13. pp. 1069–1079 ; Discussion, p. 1080, Nov. 1, 1912. Paper read before the 84. Naturforscherversamml., Münster, Sept., 1912.)—The Brownian molecular motions, the opalescence of gases in the critical state, the blue of the sky, and some other phenomena have led to a decision in favour of a real kinetic theory of gases as distinct from the traditional purely phenomenalistic thermodynamics. The difference is most clearly brought out by a definition of the steady state. This used to be considered to be the state of minimum potential, to which an undisturbed body gradually approximates. The molecular kinetic view, on the other hand, admits the probability of continual fluctuations about this state, and of occasionally serious departures from it. The Brownian motions of particles denser than the containing liquid lead to a distribution according to a "barometric" exponential law, instead of a collection of all the particles at the bottom of the vessel. The work of Perrin on liquids, and Ehrenhaft and de Broglie on gases has confirmed this fully. The rule that the mean square of the concentration equals the reciprocal of the molecules contained in it has been successfully applied by Svedberg to gamboge emulsions and colloidal gold solutions. The author shows how opalescence is due to the fluctuations in density of a gas. E. E. F.

634. *Second Virial Coefficient for Monatomic Gases and for Hydrogen below the Boyle-point.* **W. H. Keesom.** (Konink. Akad. Wetensch. Amsterdam, Proc. 51. pp. 643–648, Nov. 28, 1912. Supplement No. 26 to Communications from the Phys. Lab., Leiden.)—On the assumption that the attraction potential between the molecules may be expressed in the form $-r^{-q}$, where r is the distance between the centres of the molecules and q a constant, hydrogen, argon, and helium have been investigated at low temperatures in order to ascertain the value of q. With argon, the experimental data available are insufficient to decide between the values 3, 4, and 5, but the behaviour of hydrogen below the Boyle-point seems to be in moderately good agreement with the assumption of rigid spheres of central structure with an attraction potential proportional to $-r^{-4}$. In the case of helium, at temperatures below $-100°$ the data also point to the value 4 for q, although at higher temperatures the data are discordant. T. H. P.

635. *Isotherms of Diatomic Gases and their Binary Mixtures.* X. *Control Measurements with the Volumenometer of the Compressibility of Hydrogen at 20° C.* **W. J. de Haas.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 295–299, Oct. 24, 1912. Communication No. 127A from the Phys. Lab., Leiden.)—The compressibility of hydrogen at 20° C. is expressed by the equation, $pv_A = 1{\cdot}07258 + 0{\cdot}000667d_A + 0{\cdot}00000099d_A^2$, where p is the pressure, v_A the volume in terms of the normal volume, and d_A the reciprocal of v_A. On account of the small densities occurring in measurements made with the volumenometer, the d_A^2 term may be neglected. Comparison of the results obtained with those given by earlier investigators shows satisfactory agreement. [See Abstract No. 1870 (1911).] T. H. P.

636. *Isotherms of Diatomic Gases and their Binary Mixtures.* XI. *Determinations with Volumenometer of Compressibility of Gases under Small Pressures and at Low Temperatures.* **W. J. de Haas.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 299–306, Oct. 24, 1912. Communication No. 127B from the Phys. Lab., Leiden.)—The author discusses the pressure equilibrium

between the piezometer and the volumenometer used in the measurement of the compressibility of gases at low temperatures [see next Abstract] and deduces a formula for determining the change in the pressure-difference between the two communicating vessels as a function of the time; this formula is derived from the dimensions of the apparatus and from data determining the distribution of temperature along the glass capillary. Application of the formula to a particular case gives results in complete agreement with those observed. The conditions for the rapid establishment of pressure equilibrium are defined. T. H. P.

637. *Isotherms of Diatomic Substances and their Binary Mixtures.* XII. *Compressibility of Hydrogen Vapour at and below the Boiling-point.* **H. Kamerlingh Onnes** and **W. J. de Haas.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 405–416, Oct. 24, 1912. Communication No. 127c from the Phys. Lab., Leiden.)—To the temperature region covered by previous investigations on the equation of state for hydrogen at low temperatures the authors now add that lying between −252° and −258°, measurements being made at −252·6°, −255·5°, and −257·3°; these temperatures are expressed on the absolute scale. The value of the second virial coefficient B_A of the equation $pv_A = A_A + B_A d_A + C_A d_A^2$ is found to be −0·00047, −0·00049, and −0·00055 at −252·47°, −255·32°, and −257·10° respectively. The corrections to be applied to reduce temperatures of −252·59°, −255·45°, and −257·24° on the international hydrogen thermometer to the absolute scale are +0·118°, +0·125°, and +0·144° respectively. T. H. P.

638. *Radiation Constant.* **H. B. Keene.** (Roy. Soc., Proc. Ser. A. 88. pp. 49–60, Jan. 29, 1913.)—According to the Stefan-Boltzmann law, the radiation emitted by a full radiator to surroundings at a temperature of absolute zero is proportional to the fourth power of the absolute temperature of the radiator, or $R = \sigma\theta^4$, where R = radiation in ergs per cm.^{2} per sec., θ = absolute temperature of radiator, σ = radiation constant. The apparatus consists of an electric furnace of the Heraeus type as *emitter,* and a thin copper spherical surface as *receiver.* Outside this was another concentric sphere, and between the two the space constituted the bulb of an aniline thermometer with a capacity of 2 litres, the stem being about 1 mm. bore. The chief results are as follows:—

Temperature of Furnace.	Constant, $\sigma \times 10^5$.	
1117	5·98	in ergs cm.$^{-2}$ sec.$^{-1}$ deg.$^{-4}$
1115	5·86	
1119	5·90	
1120	5·90	
1097	5·87	

E. H. B.

639. *Theory of Radiation.* **S. B. McLaren.** (Phil. Mag. 25. pp. 43–56, Jan., 1913.)—This paper is an attempt to save the classical view of radiation as a continuous wave motion. If that can be done the author deems it a small thing to sacrifice the ordinary mechanical notions of matter. Indeed it is here considered that some such idea as that of Einstein's quantum is necessary to explain its most elementary properties. It need not be any

obscure inference from the laws of radiation. The various forms of matter are not in a continuous series; the gaps may be crossed in a radio-active transformation, but are not occupied.

The analysis then developed leads to the conclusion that to save the ether it is necessary to give up the classical mechanics. A formula for complete radiation is suggested which gives a similar result to Rayleigh's for large values of $\lambda\theta$ and to Wien's for small values. E. H. B.

640. *Wien-Planck's Radiation Constant.* **E. Warburg, G. Leithäuser, E. Hupka, and C. Müller.** (Preuss. Akad. Wiss. Berlin, Ber. 2. pp. 35–43, 1913.)—Experimental determinations were made of the constant *c* in the Wien-Planck radiation law, both with a quartz prism and with a fluorspar prism. The results are as in the table below :—

Wave-lengths. λ	Temperatures, T_1, T_2	Quartz Prism.		Fluorspar Prism.
		1337°. 1673·4°.	1673·4°. 2238·3°.	1337°. 1666·9°.
0·6563		14,385	14,335	14,608
1·132		14,395	14,354	14,491
1·329		14,386	14,351	14,573
1·588		14,360	14,370	14,599
2·172		14,379	14,425	14,625
Mean values of *c*......		14,381	14,367	
		14,370 ± 40		

E. H. B.

641. *Relative Temperature Scales of Solids.* **H. Alterthum.** (Deutsch, Phys. Gesell., Verh. 15. 2. pp. 25–33, Jan. 30, 1913.)—A theoretical discussion on the Planck-Einstein *quanta* theory. [See Abstract No. 446 (1913).] E. H. B.

642. *Equation of State for Solid Bodies.* **H. Alterthum.** (Deutsch. Phys. Gesell., Verh. 15. 3. pp. 65–68, Feb. 15, 1913.)—Mathematical. [See Abstract No. 508 (1913) and preceding Abstract.] E. H. B.

643. *On the Stability of Thermal Equilibrium.* **P. Duhem.** (Comptes Rendus, 156. pp. 597–598, Feb. 24, 1913.)—Theoretical thermodynamical discussion.

644. *Destruction of Boltzmann's Entropy Principle of the Second Virial-coefficient for Material Particles (in the Limit Rigid Spheres of Central Symmetry) which exert Central Forces, etc.* **W. H. Keesom.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 256–273, Sept. 3, 1912. Supplement No. 24B to Communications from the Phys. Lab., Leiden.)—[See Abstract No. 1356 (1912).]

645. *Theory of Black Radiation.* **M. Brillouin.** (Comptes Rendus, 156, pp. 301–304, Jan. 27, 1913.)

SOUND.

646. *Analysis of Violin Sound-waves.* **C. W. Hewlett.** (Phys. Rev. 35. pp. 359–372, Nov., 1912.)—This work is a continuation of that begun by P. H. Edwards [see Abstract No. 685 (1911)], and the same method is used, viz. a set of adjustable resonators (in this case 39, from 128 to 2552 per sec.), each provided by a Rayleigh disc, set at an angle of 45°, in its mouth. Then when the resonator responds the disc tends to set across the mouth, and the deflection is observed by a spot of light on a scale. To obviate reflection from the walls of the room, a fluffy, fibrous substance called Linofelt was used to cover them. The open strings G, D, A, and E were tested on a number of violins of poor, ordinary, and high quality, and sixteen sets of records are shown. One of these indicates what is regarded as ideal violin tone, being derived from what seemed best on the individual records. E. H. B.

647. *Compound Vibrations of Fork.* **E. H. Barton.** (Nature, 90. p. 436, Dec. 19, 1912.)—Points out that the presence and relative frequency of an upper partial vibration of a tuning-fork can be shown by a smoke trace. The note includes a print of three smoke traces for the same fork: one shows the prime alone (128 per sec.), another the second tone alone, a third the combination of the two executed together. This compound vibration is easily obtained by striking the prongs on a hard surface such as a counter. The relative frequency of upper partial and prime were about 6·25 : 1. [See Abstract No. 202 (1913).] E. H. B.

648. *Application of Resonators to Telephone Tones.* **M. Wien.** (Phys. Zeitschr. 13. pp. 1034–1036; Discussion, pp. 1036–1037, Nov. 1, 1912. Paper read before the 84. Naturforscherversamml., Münster, Sept., 1912.)—Describes the application of spherical air resonators to telephones both for the generation of pure tones and for the detection of the same when very feeble. It is considered that useful applications are possible in connection with (1) the physiology of the ear, (2) Wheatstone bridge tests, and (3) wireless telegraphy. E. H. B.

649. *Physical Objectivity of Combination Tones.* **E. Waetzmann** and **G. Mücke.** (Deutsch. Phys. Gesell., Verh. 15. 3. pp. 59–65, Feb. 15, 1913.)—As prime tones were used the sounds of (i) forks from 200 to 4000, (ii) a set of organ pipes from 128 to 1024, and (iii) small glass pipes from 1800 to 3000 per sec., which were at first chiefly adopted. These prime tones were led to a microphone and an adjustable loud-speaking telephone. The vibrations of the telephone membrane were photographed by aid of an F. F. Martens mirror arrangement and a sensitised paper on a rotating drum. As source of light an arc lamp with horizontal positive carbon was employed. A set of three photographs shows the result of one experiment and gives the vibration curves for the primaries and their resultant. The former had frequencies $p/2\pi$ and $q/2\pi$, where p and q are 2200 and 1925 respectively. The resultant curve exhibits the following three elements:—

Frequency Coefficients.	Amplitudes.
$p = 2200$	1·1
$q = 1925$	0·8
$p - q = 275$	3·4

[See Abstracts Nos. 1760 (1905) and 1739 (1906).] E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

650. *Dynamics of the Electron.* **A. Signorini.** (N. Cimento, 4. Ser. 6. pp. 257–304, Oct., and pp. 331–375, Nov., 1912.)—An attempt to develop a mathematical theory of the motion of an electron in an electromagnetic field without subjecting the electron itself *a priori* to any kinematical linkage. The only distinctive property utilised is that its dimensions are infinitesimal with respect to those of the field. Following Larmor's mechanical conception, the electrons are considered as systems possessing a finite number of degrees of freedom. In the Lagrangian function of the mechanical model (excepting the connection between kinetic and potential energy) Abraham's assumption is made, in which only electrokinetic elements appear, such as the distribution of charges and currents, and retarded relative potentials. Levi-Cività's asymptotic expression is taken for the retarded potentials, and the previous history of the motion of the electron is thus eliminated. For any given position of the electron and for a given distribution of currents and charges, the motion of the electron, which has 12 degrees of freedom, is defined by a system of 12 ordinary scalar differential equations of the second order, in which the time appears as an independent variable. E. E. F.

651. *Decrease of Speed of Electrified Particles on passing through Matter.* **N. Bohr.** (Phil. Mag. 25. pp. 10–31, Jan., 1913.)—In this paper the theory of the decrease of velocity of moving electrified particles in passing through matter is given in a form, such that the rate of the decrease depends on the frequency of vibration of the electrons in the atoms of the absorbing material. It is shown that the absorption of α-rays in the lightest elements can be calculated from the information about the number and frequencies of the electrons in the atoms which we get from the theory of dispersion, and that the values are in good agreement with experiment. For elements of higher atomic weight, it is shown that the number and frequencies of the electrons we must assume, according to the theory, in order to explain the absorption of α-rays, are of the order of magnitude to be expected. It is further shown that the theory can account for the form of the relations between the velocity of the rays and the thickness of matter traversed, found by experiments with kathode-rays and β-rays. Adopting Rutherford's theory of the constitution of atoms, it seems that it can be concluded with great certainty, from the absorption of α-rays, that a hydrogen atom contains only one electron outside the positively-charged nucleus, and that a helium atom only contains two electrons outside the nucleus. E. H. B.

652. *Possible Changes in Weight or Momentum of Charged Condenser.* **P. G. Agnew** and **W. C. Bishop.** (Phys. Rev. 35. pp. 470–476, Dec., 1912.)—There is no reason to suppose that the weight of a body is affected by its state of electrification in great enough a degree to be detected by the methods of direct weighing at present available. Yet however improbable such an effect may seem, the question cannot be settled without an appeal to experiment. Similar investigations have been made to detect possible changes in

weight due to temperature and to magnetisation and gave, as was anticipated, negative results. The same remark applies to the present research which may be summarised as follows :—(1) Charging a 10-mfd. condenser to 240 volts did not change its weight by 0·01 mgm., or one part in a hundred millions. (2) In charging and discharging the same condenser no momentum effect having opposite signs on charge and discharge as great as 0·01 dyne-sec. was detected. (3) Similarly no momentum effect having the same sign on charge and on discharge as great as 0·0004 dyne-sec. was detected. E. H. B.

653. *Electric Conduction in Metals.* **W. Wien.** (Preuss. Akad. Wiss. Berlin, Ber. 7. pp. 184–200, 1913.)—Mathematical discussion on the *quanta* hypothesis. The results reached are in close agreement with the theoretical and experimental results of K. Onnes. E. H. B.

654. *Vibration and Residual Charge.* **P. L. Mercanton.** (Archives des Sciences, 35. pp. 48–56, Jan., 1913.)—Hopkinson, following the analogy between residual charge and magnetic polarisation, investigated in 1876 the effects produced by vibration on the residual charge of a Leyden jar. He found that mechanical shocks always accelerated the appearance of the residual charge. The author has carried out many similar investigations but in no case has he found that vibrations have any effect in accelerating the appearance of the residual charge. Brentano also has obtained negative results. The reason of the great divergence between their results and those of Hopkinson are still obscure. A. R.

655. *Imperfect Dielectrics.* **K. W. Wagner.** (Deutsch. Phys. Gesell., Verh. 15. 2. pp. 45–46, Jan. 30, 1913.)—A note on the anomalies of solid dielectrics, residual charge, energy loss in alternating fields, etc. [See Abstract No. 650 (1908).] E. H. B.

656. *Stereoscopic Lightning Photographs.* **B. Walter.** (Phys. Zeitschr. 13. pp. 1082–1083; Discussion, pp. 1083–1084, Nov. 1, 1912. Paper read before the 84. Naturforscherversamml., Münster, Sept., 1912.)—Photographs of lightning flashes were taken simultaneously with three cameras, two of them mounted 2 m. apart on a fixed stand, and the third kept in motion by clockwork. The photographs so obtained give information concerning the real course of the flashes and their duration. A couple of stereoscopic views are reproduced, which show that the lightning flash consisted of two spatially separate discharges. E. E. F.

657. *Atmospheric Electrification during South African Dust Storms.* **W. A. D. Rudge.** (Nature, 91. pp. 31–32, March 13, 1913.)—The author has made observations of the potential gradient during dust storms and found that very extraordinary variations are caused by the presence of dust in the atmosphere. The dust was either sand or of a siliceous nature. Continuous records have been taken at Bloemfontein during 6 months, and typical records are reproduced showing (1) a normal fine weather record, (2) a mild dust storm, and (3) a severe dust storm. In (1) the potential gradient is positive during the 24 hours with two well-defined maxima of about 350 volts/m., in (2) these maxima are obliterated and the gradient is slight throughout the day, and in (3) large negative values prevail during the time of the dust storm. The article concludes with a description of an electrical machine which, if exposed during a dust storm, will give sparks up to 1·5 cm. in length. The action of the machine depends upon the sand being positively electrified. J. S. Di.

658. *Atmospheric Electricity.* **G. C. Simpson.** (Phys. Zeitschr. 14. pp. 41–45, Jan. 1, 1913.)—Describes some portable instruments for measuring atmospheric electricity, designed for use in the most widely varying climates. For strong insulators the author uses small cylindrical tin boxes, into which sulphur is poured round a stout brass wire. A perforated lid, not touching the wire, is slipped over the open end to keep the sulphur clean. As a collector he uses a wire drawn horizontally some distance from the ground between two uprights. To this he attaches in the centre a length of cotton twine soaked in a solution of nitre and dried. The battery recommended consists of modified Daniell cells. A stout test-tube holds two narrow tubes containing respectively the zinc rod in $ZnSO_4$ and the copper rod in $CuSO_4$. These tubes are drawn out to capillaries below, and open into a space filled with Fuller's earth soaked in $ZnSO_4$. This space also contains a few pieces of free Zn wire to absorb any stray $CuSO_4$ which may penetrate into it. The opening at the top is covered over with thick machine oil. A battery of 100 such cells has been in unimpaired use at Simla for 8 years. To charge an electroscope, the author uses a small ebonite rod working in a tube filled with flannel. When electrified the rod pushes against a spring into a small brass tube, to which the charge is thus communicated. E. E. F.

DISCHARGE AND OSCILLATIONS.

659. *Ionisation Voltages in Gases.* **J. Franck** and **G. Hertz.** (Deutsch. Phys. Gesell., Verh. 15. 2. pp. 34–44, Jan. 30, 1913.)—By Lenard's method the voltages needed for ionisation were measured for various pure gases, the results being as follows:—

Gas	He	Ne	A	H	O	N
Volts	20·5	16	12	11	9	7·5

[See Abstracts Nos. 843 (1908), 552, and 907 (1912).] E. H. B.

660. *Conductivity of Rarefied Gas affected by Magnetic Fields.* **H. Stassano.** (Comptes Rendus, 155. pp. 911–914, Nov. 4, 1912.)—Describes experiments which show that the discharge in a vacuum tube is facilitated at times by a magnetic field whose strength must be graduated to suit the degree of rarefaction in use. [See Abstract No. 2027 (1902).] E. H. B.

661. *Hertz-Hallwachs Effect.* **G. Reboul.** (Le Radium, 9. pp. 400–404, Nov., 1912.)—A plate of copper is slowly lowered vertically into a vessel filled with bromine vapour. The deposit of bromide arranges itself in a narrow wedge showing interference colours, from which its thickness can be computed. A slit illuminated by a mercury lamp is focussed on the plate, the image being parallel to the colour-fringes. Whereas in former experiments [Abstracts Nos. 671, 1413 (1912)] the photoelectric emission varied slowly with the thickness, a displacement from one fringe to another of a freshly prepared plate shows maxima and minima of emission corresponding to maxima and minima of absorption of ultra-violet light. These are reversed by fatigue. E. E. F.

662. *Production of Ozone by Lenard Rays.* **F. Krüger.** (Phys. Zeitschr. 13. pp. 1040–1043, Nov. 1, 1912. Paper read before the 84. Naturforscher-versamml., Münster, Sept., 1912.)—In the experiments kathode rays emerged from a kathode-ray tube through an Al window and produced ionisation in

a chamber containing either pure oxygen or pure nitrogen. With a given intensity of radiation the following were determined: (1) Ionisation in oxygen, (2) number of molecules of ozone produced per sec., (3) ionisation in nitrogen. The estimation of the ozone was determined by the absorption of the ultra-violet line $\lambda = 254\ \mu\mu$ from a mercury lamp. The results with different intensities of radiation are given in the following table:—

Experiment Number.	Number of Ions produced per second.		Number of Molecules of Ozone.
	In Oxygen.	In Nitrogen.	
1	$0{\cdot}70 \times 10^{14}$	$6{\cdot}0 \times 10^{14}$	$7{\cdot}0 \times 10^{14}$
2	$0{\cdot}61 \times 10^{14}$	$1{\cdot}9 \times 10^{14}$	$2{\cdot}0 \times 10^{14}$
3	$0{\cdot}56 \times 10^{14}$	$1{\cdot}2 \times 10^{14}$	$1{\cdot}1 \times 10^{14}$
4	$0{\cdot}45 \times 10^{14}$	$1{\cdot}4 \times 10^{14}$	$1{\cdot}4 \times 10^{14}$
5	$0{\cdot}21 \times 10^{14}$	$0{\cdot}5 \times 10^{14}$	$0{\cdot}33 \times 10^{14}$

A correction was applied for the decay of the ozone due to the proximity of metal surfaces. The results show that the number of ozone molecules produced is in excess of the number of ions produced in oxygen and approximates more nearly to the number of ions produced in nitrogen under the same conditions. E. M.

663. *Kathode Rays.* **S. Rudberg.** (Ark. för Mat., Astron. och Fysik, Stockholm, 8. 3. pp. 1–16, 1912.)—Answers in the affirmative, distinctly, the question whether the absorption coefficient of kathode rays passed through metallic laminæ depends on the material of the kathode; but the subject needs further investigation to ascertain the law of the relation. Kathode rays from a heavier metal are more penetrative than those from a lighter metal even though the voltage used be considerably smaller; and the heavier the metal of the kathode the more nearly does the penetrating power approach that of the β-rays. This seems to indicate that the particles shot off are proper metallic ions, and that the particles in the β-rays may also be of the same character. A. D.

664. *Dielectric Cohesion.* **E. Bouty.** (Comptes Rendus, 155. pp. 1207–1208, Dec. 9, 1912.)—Describes a method of ascertaining the dielectric cohesion with very small quantities of a gas by observing the value of external field necessary to produce a visible glow in the gas contained in a small (3-cm.) bulb. A. D.

665. *Righi's Luminous Masses.* **L. Amaduzzi.** (Phys. Zeitschr. 13. pp. 1202–1206, Dec. 15, 1912.)—Studies the luminous masses obtained in vacuum tubes with alternating discharges, as described by Righi in 1891 and 1895 [see also Abstract No. 912 (1912)]. The alternating-current ions were obtained by working an induction coil of 50 cm. spark length from an a.c. supply of 42 ∿ at 110 volts. On reducing the pressure from atmospheric to a few mm. of Hg the brushes at the electrodes lengthened out and a uniform feeble reddish glow filled the whole length (1·4 m.) of the tube. At 14 mm. Hg reddish-violet masses about 15 cm. long appeared. These merge into one streak at 10 mm. pressure. At a given pressure they have a fixed length, so that their number varies as the length of the tube. Their number can,

however, be reduced by increasing the inductance in the circuit. The masses are split in the middle by a slanting division in a magnetic field. Their alternating shapes are best separated by a revolving mirror. E. E. F.

666. *Electric Loss in a Plane-Sphere System in Air.* **A. Guillet** and **M. Aubert.** (Comptes Rendus, 156. pp. 458–460, Feb. 10, 1913.)—When the electrodes are dissimilar the phenomena differ depending on which is the positive electrode. In the present note the results of experiments on a system composed of a plane and a sphere are given. From the electrometer readings we deduce at any instant the potentials of the electrodes, their charge, and the apparent value of the leakage current. The sphere being connected with the earth and the plane insulated, the latter is electrified by means of a proof plane. The sphere approaches the plane until its centre attains a certain definite minimum position from it which the authors call a *position d'arrêt.* The ratio of the potential V of the plane to this distance d is found to be different, depending on whether the plane is positively or negatively electrified. It is found that if V_p and V_n be the positive and negative potentials at the neutral point for the same initial distance between the plane and the sphere, then V_n/V_p is a constant and equals 1·253 very approximately. This ratio the authors call the "coefficient of dissymmetry" of the system. A. R.

667. *End Correction to Rods in Electrical Problems.* **Rayleigh.** (Phil. Mag. 25. pp. 1–9, Jan., 1913.)—In a previous paper [see Abstract No. 2656 (1904)] the author endeavoured to show that the difference between the half wave-length of the gravest vibration and the length (l) of the rod (of uniform section) tends to vanish relatively when the section is reduced without limit, in opposition to the theory of Macdonald which makes $\lambda = 2{\cdot}53\, l$. Understanding that the argument there put forward is not considered conclusive, the author has tried to treat the question more rigorously, but the difficulties in the way are rather formidable. And this is not surprising in view of the discontinuities presented at the edges where the flat ends meet the cylindrical surface. The problem assumes a shape simpler in some respects if we suppose that the rod of length l and radius a is surrounded by a cylindrical co-axial conducting case of radius b extending to infinity in both directions. One advantage is that the vibrations are now *permanently maintained,* for no waves can escape to infinity along the tunnel, seeing that l is supposed great compared with b. The greatness of l secures also the independence of its two ends, so that the whole correction to the length, whatever it is, may be regarded as simply the double of that due to the end of a rod infinitely long. The analysis then follows and shows that, in any case, the correction δl to the length of the rod vanishes in the electrostatical problem when the radius of the rod is diminished without limit, a conclusion which the author extends to the vibrational problem specified in the earlier portion of this paper. E. H. B.

668. *Complete Solution of the Differential Equations of two Magnetically Coupled Oscillatory Circuits of Constant Damping.* **F. Kiebitz.** (Ann. d. Physik, 40. 1. pp. 138–156, Dec. 31, 1912.)

669. *Theory of Photoelectric Current in Gases.* **A. Partzsch.** (Ann. d. Physik, 40. 1. pp. 157–193, Dec. 31, 1912. Abbreviation from Dissertation, Rostock.)—[See Abstract No. 552 (1912).]

670. *Stroboscopic Effects obtained with Incandescent Filaments as Illuminants.* **C. F. Lorenz.** (Electrical World, 60. pp. 1146–1148, Nov. 30, 1912.)—An account of some experiments with incandescent (tungsten) filaments immersed in an inert cooling gas (ammonia). The original pages should be referred to. L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

671. *Resistance of Solid and of Liquid Mercury.* **A. Baltruszajtis.** (Acad. Sci. Cracovie, Bull. 9a. pp. 888–898, Nov., 1812.)—The ratio of the specific resistance of solid mercury to that of liquid mercury, both being at the freezing-point of mercury, was found to be 4·90. The resistance of solid mercury was measured at as high a temperature as —38·91° and that of liquid mercury at as low a temperature as —38·11°. The resistance of solid mercury is very approximately a linear function of the temperature. F. E. S.

672. *Measurement of High Resistances.* **Tournier.** (Comptes Rendus, 155. pp. 1242–1243, Dec. 9, 1912.)—A description of a modification of the potentiometer method of comparing resistances; a quadrant electrometer being used with alternating currents so that the method is applicable to electrolytes. J. J. S.

673. *Resistance of Metallo-crystalline Junctions.* **A. Wesely.** (Phys. Zeitschr. 14. pp. 76–81, Jan. 15, 1913.)—Measures the resistance of crystals of galena, pyrites, and markasite between electrodes of amalgamated lead at various pressures, and between Hg terminals at various temperatures. That of a cm.-cube of galena was 0·06596 ohm under moderate pressure, which could be reduced to 0·00142 ohm by screw compression. The amount of pressure was not determined. The change of resistance with temperature, which is always non-metallic, is well expressed by Koenigsberger's equation. But at higher temperatures highly resisting transition layers are easily formed. E. E. F.

674. *Artificial Metallic Conductors.* **K. Baedeker.** (Phys. Zeitschr. 13. pp. 1080–1082; Discussion, p. 1082, Nov. 1, 1912. Paper read before the 84. Naturforscherversamml., Münster, Sept., 1912.)—Cuprous iodide has the property of absorbing iodine in the solid state and thus acquiring electrical conductivity. Every gramme of CuI can absorb 3·3 mgm. of iodine, and thus acquires a conductivity which amounts to 100 times that of sulphuric acid of max. conductivity. A feeble action of the same kind is found in AgI. The iodides are not decomposed by the current, and fit into the Volta series. CuI preparations of high conductivity have the ordinary metallic temperature-coefficient. The Hall-effect in these preparations is directly proportional to the resistance, at least in the specimens of medium conductivity. The thermoelectric force between two specimens of different conductivities is theoretically $= (R/F) \log_e (n_1/n_2)$, where $R = 8{\cdot}316 \times 10^7$, $F = 9647$, and n_1, n_2 are the electron concentrations. This can be put $= 198{\cdot}5 \log_{10} (W_2/W)$ microvolt-degrees, where W_2, W_1 are the resistances. This formula is closely rendered by the observed values. In the *discussion*, **Glatzel** proposed to use CuI to construct photoelectric cells free from inertia. **Nernst** pointed out that the validity of the gas laws was assumed for electrons, which involved certain difficulties. E. E. F.

675. *The Silver Voltameter.* **E. B. Rosa, G. W. Vinal, and A. S. McDaniel.** (Electrical World, 61. pp. 84–85, Jan. 11, 1913.)—[See also Abstract No. 501 (1913).] The small porous-cup voltameter was found to be most convenient and reliable to use as a standard. As a test of the reproducibility of this form, there were tabulated 54 deposits, made in pairs (with 2 exceptions), and the average deviation of each value from the mean of each group of two or three cups was found to be 1 part in 100,000. The mean value led to the value 1·01827 int. volts at 20° C. being assigned to the Weston normal cell. Comparison of the large porous-cup voltameter with the smaller size showed consistently a heavier deposit in the former by about 5 parts in 100,000, and the siphon form, which required a very large volume of electrolyte, gave a still greater excess. This excess of deposit in the larger sizes of voltameter was roughly proportional to the volume of electrolyte and the authors have called this the "volume effect." Eventually, electrolyte was prepared which satisfied all the criteria for purity and brought all the sizes of voltameters into agreement. With regard to chemical tests for purity of the electrolyte, iodeosine was used as an indicator and by means of it 1 part in 1,000,000 of acid or alkali could be detected. For the detection of reducing impurities, a titration test with (N/1000) $KMnO_4$ solution has proved very valuable. The authors give particulars of methods for purifying $AgNO_3$ and also state that experiments made by them indicate that there is no temperature coefficient to the silver voltameter. F. E. S.

676. *Effect of Light-radiation on a Telephone.* **O. Grotrian.** (Ann. d. Physik, 39. 6. pp. 1625–1632, Dec. 23, 1912.)—When light is allowed to fall on the plate of a telephone receiver, a momentary current is induced in the coil of the receiver. To investigate the effect, light from an arc lamp is thrown on the plate after passing through various filters. As the heat waves are cut out, the effect becomes very small. There is, however, still a perceptible effect with ultra-violet rays. T. P. B.

677. *An Electric Constriction Experiment.* **E. F. Northrup.** (Metallurgical and Chem. Engin. 11. p. 48, Jan., 1913.)—A wooden trough is filled with mercury, and a piece of sheet copper floated on the mercury; electrodes are inserted into the mercury at the ends of the trough. The copper has the shape of a sector, one end pointed, the other rounded. When current from a 12-volt battery is turned on, the copper float moves with its rounded end forward, because copper conducts much better than mercury, and the stream-lines are concentrated at the sharp point. When the float is held stationary, the mercury becomes agitated. An amperemeter has been based upon this observation. H. B.

678. *Determination of Capacity of Coils.* **W. Hüter.** (Ann. d. Physik, 39. 6. pp. 1350–1380, Dec. 23, 1912. Extract from Dissertation, Munich, 1911.)—Single-layer coils of copper wire wound bifilarly are used. The frequency n employed in the determinations was 480 per sec. It is shown that with the low self-induction (L) and capacity (C) employed, the resistance-operator (R) of the coil is equal to $r(1 + i2\pi n\phi)$, r being the continuous-current resistance of the coil, and ϕ, the phase-factor, being equal to $L/r - rC$. ϕ is determined by a Wheatstone bridge method. L and C are separated by determining ϕ with the coil at different temperatures. T. P. B.

679. *Electrical Disintegration of Metals and its Possible Use as a Method of Testing.* **C. Benedicks.** (Rev. de Métallurgie, 9. pp. 1094–1102, Dec., 1912.)

—The method of electrical disintegration used by Svedberg in colloidal synthesis has been studied with a view to its application to the testing of metals. After the passage of a spark from a Ruhmkorff coil and Leyden jar between electrodes of metals immersed in ether, numerous small craters appear on the surface. One crater is considerably larger than the others and evidently corresponds to the pilot spark, while the smaller ones correspond to subsequent oscillatory discharges. Comparison with the craters of fusion produced by impinging a fine jet of hot air on asphalt, shows that the craters are true centres of fusion due to the voltaic arc caused by the passing spark. At the same time particles of molten metal are projected mechanically. That there is considerable mechanical energy developed is shown by the fact that unless the electrodes are tightly clamped they are forced apart during the passage of the spark. From these facts it is fairly obvious that the disintegration is brought about thermodynamically, the essential factors being the total heat of fusion and the thermal conductivity of the material, while the total heat of vaporisation, the viscosity, and superficial tension of the molten metal play minor parts. A series of determinations made on eutectic alloys with low total heats of fusion gives low rates of disintegration, showing that the viscosity of molten alloys is greater than that of the pure metals. The size of the craters (about 0·15 mm. in diam.) renders the method a macroscopic rather than a microscopic one. It provides the only known method of removing from a plane metallic surface, the most fusible constituent or the constituent having a thermal conductivity lower than that of the groundmass. Examination of a series of steels shows that the size of the craters increases with the content of carbon. Cementite-rich and slag-rich areas are shown very distinctly by this method which is an admirable way of rendering lack of homogeneity visible to the naked eye. F. C. A. H. L.

680. *Effective Capacity of Quadrant Electrometer when used as Quantometer.* **R. Beattie.** (Electrician, 70. pp. 683–685, Jan. 10, 1913.)—If C is the capacity of the electrometer and V the potential of the needle, the latter is subject to a resultant controlling couple due to the action of (i) a mechanical control $k_1\theta$, (ii) a distortional electrostatic control $k_2V^2\theta$, and (iii) an inductional electrostatic control $k_3V^2\theta/C$, k_1, k_2, and k_3 being instrumental constants. The deflection θ of the needle varies as $qV/(C + k_2V^2C/k_1 + k_3V^2/k_1)$. The denominator can be put in the form $C + k_3V^2/(k_1 + k_2V^2)$, which is regarded as the effective or dynamical capacity of the instrument. Under certain conditions, the distortional control may become negative and equal to the mechanical control. With inductional control alone, the needle moves just far enough to make the charge induced on the isolated quadrants exactly equal to the externally communicated charge. The action of an electrometer so adjusted may be compared with that of an electromagnetic quantometer or fluxmeter, where, in the absence of mechanical control, the moving coil rotates just so far as to make the quantity induced in the circuit equal to the quantity sent through it from outside sources. G. E. A.

681. *New Scheme of Connections for Spark-coil Interrupters.* **W. Burstyn.** (Elektrotechn. Zeitschr. 33. p. 1109, Oct. 24, 1912.)—Owing to the difficulty experienced in working spark coils with hammer interrupters off the supply voltage and the heavy strain on the contacts if ordinary resistance is put in series, the author has devised a method which, it is claimed, does away with these difficulties. The arrangement consists, firstly, in inserting a very high series resistance; secondly, in providing an interrupting key (normally open)

in the make-and-break circuit (normally closed) and a condenser of about 1 mfd. capacity in the interrupter magnet circuit which is in parallel with the former circuit. The supply current charges the condenser through the interrupter magnet winding, and on closing the key the condenser discharges through the magnet winding, in the form of a somewhat damped oscillating current. The magnetic impulse imparted attracts the armature and opens the "break" contact, so that condenser is again able to charge itself. On the break contact closing again, on the return swing of the spring, the condenser again discharges itself, and so on, as long as the key is held down. The contact has in this way only to deal with the small non-inductive current passing through the series high resistance. Diagrams are given of the arrangement and of the circuit as applied to spark coils, for which latter purpose another condenser should be inserted in series with the interrupter. The arrangement forms the subject matter of a German Patent application. L. H. W.

682. *Thermoelectric Couples.* **G. Meslin.** (Comptes Rendus, 155. pp. 906–908, Nov. 4, 1912.)—In calculating the magnitude of the Thomson-effect and determining what portion of the e.m.f. is due, in the case of particular couples, to the Thomson- and what to the Peltier-effect a graphical method may be used. This method is available in all cases where the e.m.f. may be represented by the formula $E = m(T_1 - T_2)[T_0 - (T_1 + T_2)/2] \ldots (1)$. It consists in drawing a parabola such that from its dimensions the values of e.m.f., Peltier-, and Thomson-effects may be deduced. This parabola, $Y = mT(T_0 - T/2)$, where Y and T are the two co-ordinates, may be used for all couples which may be represented by formula (1); it is only necessary to *reduce* suitably the equation for the particular case required which has its own particular values for the constants m and T_0. So that it may be enunciated that: (*a*) For corresponding temperatures the e.m.f. are corresponding; and (*b*) at corresponding temperatures, the thermoelectric powers are corresponding, as well as the values of the Peltier- and Thomson-effects. These theorems result from the fact that formula (1) contains only two constants. Hence a table may be drawn up, to facilitate calculations, of the e.m.f. and the part due to the Peltier- and Thomson-effects in different cases. The present paper contains a diagram of the parabolas mentioned and the full paper to be published elsewhere gives a table such as that referred to. J. J. S.

683. *Thermal E.M.F. of Tungsten and Molybdenum.* **E. F. Northrup.** (Metallurgical and Chem. Engin. 11. p. 45, Jan., 1913.)—Although tungsten and molybdenum oxidise at high temperatures the author has been able to obtain the temperature-e.m.f. curve of a thermo-couple composed of these two metals. In the experiments, temperatures were measured by means of a Pt and Pt-Rh thermo-couple. For the range 0—1000° C. the e.m.f. was found to be given in microvolts by $E = 4{\cdot}61t - 0{\cdot}00436t^2$ and when the cold junction is at 0° C., the e.m.f. is a maximum at 530° C. and is zero at 1060° C. In this range the current flows from W to Mo at the hot junction. The author suggests that, if all samples are found to behave in the same way, the neutral point would be a convenient method of fixing the temperature, 1060° C. He thinks that it is quite likely that a case will be found for protecting the couple against oxidation at high temperatures (such as 2000° C.). W. C. S. P.

684. *Electron Theory of Thermoelectricity.* **O. W. Richardson.** (Phil. Mag. 24. pp. 737–744, Nov., 1912.)—The author discusses the criticisms of

N. Bohr [Abstract No. 1398 (1912)] and H. A. Wilson on his former papers. The difference between Bohr's results and the author's may arise from the neglect to include effects arising from a possible difference in the rate of transference of kinetic energy by an electric current in different materials. In the present paper the previous calculations are extended to include these effects. It seems probable that effects due to chemical action ought to be included, and recent experiments by Pring and Parker on carbon and of Fredenhagen on sodium and potassium strengthen this probability. Richardson considers that electronic emission may be conditioned by chemical action, but thinks that there is considerable evidence in favour of the view that there is an emission of electrons from hot conductors which is independent of chemical action. J. J. S.

685. *Damped Moving-magnet Galvanometer.* **C. Féry.** (Comptes Rendus, 155. pp. 1008–1010, Nov. 18, 1912.)—In moving-coil galvanometers the damping due to induced currents brought about by the motion of the magnet is insufficient. The author gives a brief description of an instrument in which the damping has been increased to its critical value by suspending the magnet with each pole between two pairs of coils which are sufficiently close to be equivalent to a solenoid. He also describes an astatic damped galvanometer which gives 1 mm. deflection at 1 m. for a current of 8×10^{-10} amp. The resistance of this instrument is only 2 ohms and it has a period of 15 secs.
W. C. S. P.

686. *Improved Influence Electrical Machine.* **H. Wommelsdorf.** (Ann. d. Physik, 39. 6. pp. 1201–1206, Dec. 28, 1912.)—The author has so perfected his influence machine [see Abstract No. 131 (1908)] that it has now been put upon the market, and he claims that in reliability and efficiency it easily surpasses all other influence machines. Tables of voltage and current strength are given to show this. As insulating material he uses ebonite covered with a film of "bakelite." The conducting parts are completely embedded in insulating material. The electricity is taken off from a slit in the edge of the rotating plates. T. P. B.

687. *Electric Furnace for Experiments in Vacuo at Temperatures up to 1500° C.* **R. E. Slade.** (Roy. Soc., Proc. Ser. A. 87. pp. 519–524, Dec. 13, 1912.)—This furnace consists of a Pt-tube 2 cm. in diam. and 17 cm. long, with walls 1 mm. thick. This was mounted in water-cooled brass terminals at the ends. By means of a current of 350–500 amps. at 3–4 volts passed through the tube, the interior of the latter attained a temperature of 1400–1500°. The tube is fitted in an asbestos box filled with magnesia, and the whole furnace is placed under an iron dome. Arrangements are made for evacuating the furnace, for reading the internal pressure, for measuring the temperature by means of a thermo-element, etc. Diagrams and a detailed description of the apparatus are given. T. H. P.

ALTERNATING CURRENTS AND MAGNETISM.

688. *Alternate-current Circuits with Electric Valves.* **N. Papalexi.** (Ann. d. Physik, 39. 5. pp. 976–996, Dec. 5, 1912.)—Treats the behaviour of Al valves both theoretically and experimentally. The action depends largely upon the inductance and resistance of the circuit. If there is only ohmic resistance in circuit, the action of the valve consists simply in weakening the

phases in accordance with its resistance in the two directions. If there is a high inductance in circuit, the resulting current has a d.c. component and a superimposed sine component of the amplitude of the direct current. The effective current is $\sqrt{8}$ times greater than if the valve is short-circuited. The transformation ratio can be raised from some 64 per cent. to about 82 per cent. by the insertion of a suitable inductance. The dynamical characteristics of Al valves were studied by means of a Braun tube. It was found that shortly after their formation the valves are nearly perfect valves, and the theoretical deductions are confirmed. But the valves deteriorate after a short time which depends upon the constants of the circuit. E. E. F.

689. *Kinetic Theory of Magnetism.* **E. Schrödinger.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 1305–1328, July, 1912.)—Shows mathematically that N *free* electrons of the mean free path λ contained in unit volume of a body impart to it a diamagnetic susceptibility proportional to $N\lambda^2$, and to a first approximation independent of the field. In Bi the susceptibility calculated is of the order of the observed value, but in metals of greater conductivity the calculated value is much higher, unless improbably small wave-lengths are assumed. The author thinks the observed susceptibilities of feebly magnetic bodies are usually the differences between a large Langevin paramagnetism and the diamagnetism due to free electrons. This would explain the discrepancy between Honda's and Owen's temperature curves and the Curie-Langevin laws. Thus in gases, in electrolytes, and in strongly paramagnetic bodies these laws are obeyed. In gases and electrolytes, as well as insulators like P, S, SiO_2, there is no metallic conductivity, *i.e.* no free electrons. The author's theory demands for the susceptibility of all metallic conductors a positive term proportional to the square of the field, and this should be most perceptible at low temperatures. Thus, in copper at 20° abs. the susceptibility in the strongest fields should differ from that in weak fields by 25 per cent. E. E. F.

690. *Absolute Susceptibility of Liquids.* **W. J. de Haas** and **P. Drapier.** (Deutsch. Phys. Gesell., Verh. 15. 3. p. 92, Feb. 15, 1913.)—A continuation of research [see Abstract No. 1890 (1912)]. The value found for water at 22° in a nitrogen atmosphere was $-0{\cdot}726 \times 10^{-6}$, and in air $-0{\cdot}747 \times 10^{-6}$. A fuller account will appear in the Annalen. G. E. A.

691. *Magnetism and Molecular Structure.* **E. Holm.** (Ark. för Mat. Astron. och Fysik, Stockholm, 8. 16. pp. 1–59, 1912.)—After referring to the various hypotheses as to molecular structure which have been put forward since that of Poisson to explain the process of magnetisation, the more recent development of the electron and magneton theory of Langevin and Weiss is discussed at full length. The extent to which the phenomenon of dia-, para-, or ferro-magnetism appears in a body depends only on the molecular state of that body. If the molecule or atom which carries the free magnetons is of small mass, the body exhibits diamagnetic properties. If the magnetic intensity produced by these free magnetons can overcome the diamagnetism of the bound magnetons, then paramagnetism is displayed. If, however, many carriers of free magnetons combine, so as to greatly increase the total mass of the molecule without altering the saturation intensity per unit of mass, the body exhibits ferromagnetism. If polymerisation can be effected between the molecules with free magnetons, the susceptibility of the body is increased, as in Heusler's alloy. Polymerisation between the molecules of a

body is influenced, not by its magnetic condition, but by its temperature. Within the γ region, iron exhibits progressive polymerisation, and the same phenomenon is shown by most elements within a considerable range of temperature above −180° C. G. E. A.

692. *Demagnetisation and Recovery of Permanent Magnets.* **S. Sano.** (Electrical World, 61. pp. 96–97, Jan. 11, 1912.)—The effect upon the magnetism of a horseshoe magnet of rubbing the armature on the surface of the magnet from the poles towards the curved portion was measured by observing the throw on a ballistic galvanometer joined to a coil inserted between the poles when the coil was suddenly withdrawn. The strength of the magnet was lowered considerably by rubbing it with the armature when the magnetisation was high, but it is not so much affected after the magnetisation has been lowered. After the first stroke the magnetic force was decreased by about 25 %, while from the 33rd to the 63rd stroke the percentage throw of the galvanometer decreased only from 51·6 to 50·8. In a second experiment the keeper was caused to slide upon the side of the magnet first in one direction and then in the opposite. The first positive stroke decreased the throw of the galvanometer from 68 to 50·5, and the next negative stroke increased it to 51·5. From the sixth reading on, the recovery of magnetisation due to negative rubbing was almost complete. J. J. S.

693. *Paramagnetism at Low Temperatures.* **H. Kamerlingh Onnes** and **E. Oosterhuis.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 322–329, Oct. 24, 1912. Communication No. 129B from the Phys. Lab., Leiden.)—An account is given of the continuation of experiments discussed formerly by Onnes and Perrier. The attraction excited by a non-homogeneous field upon a long cylinder of the experimental substance was again measured. This latter was finely powdered and contained in a glass tube. The effect of the glass was eliminated, the tube being taken twice as long as the part containing the powder. Anhydrous ferrous sulphate and also a specimen not quite anhydrous were examined at room temperature and at the temperatures of liquid ethylene, liquid nitrogen, and liquid hydrogen. The deviations from Curie's law are discussed. The formula $\chi(T+\Delta')=C'$, used by Weiss and Foëx, was found to apply in general for temperatures not below −208° C. Other substances were examined, and it was found that gadolinium sulphate follows Curie's law over the whole region of low temperatures down to the lowest hydrogen temperature, 14°, and is thus a normal paramagnetic substance. Down to the lowest hydrogen temperature dysprosium oxide obeys the law $\chi(T+\Delta')=C'$, with Δ' and C' positive. Over this region of temperature it shows thus a disturbance of the first kind, due to a Weiss molecular field of opposite sign. Down to −208° C. manganese chloride is normal. At hydrogen temperatures it deviates, showing a disturbance of the first kind. Crystallised ferrous sulphate behaves similarly. Anhydrous ferrous sulphate and the sulphate not quite anhydrous show a disturbance of the first kind down to −208° C. At hydrogen temperatures they show a disturbance of the second kind (both Δ'' and C'' negative). With ferric sulphate a dependence of the susceptibility on the magnetic field was found at hydrogen temperatures, which leads to the presumption that at these temperatures there exists ferromagnetism in a substance which at ordinary temperatures is paramagnetic. Further results are to be given in a subsequent paper. J. J. S.

694. *Hall-effect and Change in Resistance in a Magnetic Field at Low Temperatures.* **H. Kamerlingh Onnes** and **B. Beckman.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 307–318, Oct. 24, 1912. Communication No. 129A from the Phys. Lab., Leiden.)—An investigation of the Hall-effect and the change in resistance produced by a magnetic field was carried out at temperatures down to the boiling-point of hydrogen and at lower temperatures. Experiments were made first with a wire of electrolytic Bi to test its change of resistance; the change in different fields was similar to that found with liquid air. The results with plates of compressed electrolytic Bi as to Hall-effect and increase of resistance are given in a series of tables. With one disc the Hall-coefficient (R) approached a limiting value 100, the highest yet obtained for Bi. The value increases with the field (H). All the coefficients obtained for Bi plates are *negative.* The value of R for other metals was also investigated, and at hydrogen temperatures was as follows :—

T.	Au_{pI}.	Ag_{pI}.	Cu_{pI}.	Pd_{pI}.
29·0°	$7{\cdot}24 \times 10^{-4}$	$8{\cdot}00 \times 10^{-4}$	$4{\cdot}92 \times 10^{-4}$	$6{\cdot}75 \times 10^{-4}$
20·3	$9{\cdot}81 \times 10^{-4}$	$10{\cdot}14 \times 10^{-4}$	$6{\cdot}62 \times 10^{-4}$	$13{\cdot}68 \times 10^{-4}$
14·5	$9{\cdot}82 \times 10^{-4}$	$9{\cdot}91 \times 10^{-4}$	$6{\cdot}56 \times 10^{-4}$	$13{\cdot}85 \times 10^{-4}$

The change in the Hall-coefficient for Ag and Au takes place chiefly below —190° C., and becomes practically constant again in the region of liquid hydrogen temperatures. While at ordinary temperatures the change caused in the resistance of these metals by the magnetic field is extremely small, at hydrogen temperatures it becomes quite appreciable. The Hall-effect was observed in a Bi crystal with the axis perpendicular to the field. At hydrogen temperatures R is positive and approximates to a constant value ; at ordinary temperature it is RH, corresponding to negative values of R, which approaches a constant value. [See next Abstract.] J. J. S.

695. *Hall-effect and Change in Resistance in a Magnetic Field at Low Temperatures.* **H. Kamerlingh Onnes** and **B. Beckman.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 319–321, Oct. 24, 1912. Communication No. 129C from the Phys. Lab., Leiden.)—This is a continuation of the account of experiments on Bi at and below the boiling-point of hydrogen. As suggested by J. Becquerel [Abstract No. 1448 (1912)], the fact that the Hall-effect for Bi in strong fields can be represented by a linear function of the field strength may be regarded as resulting from the composition of the effect from two separate components. One of these is proportional to the field, and was found by the authors to be always negative for plates of compressed electrolytic Bi. The second approaches a limiting value and was found to be constant at hydrogen temperatures in fields greater than 8 kilogauss. That is, the law of linear dependence upon the field is obeyed by the first component of Becquerel in fields greater than 8 kilogauss. Referring to the equation $RH = a'H + b'$, on going down to liquid-hydrogen temperatures the constant b', the max. value of the second Becquerel component, which is negative at ordinary temperatures, becomes positive in the case of plates Bi_{pI} and Bi_{pIII}. At hydrogen temperatures the sign of the Hall-effect reverses and becomes positive, increasing linearly with the field for fields above

3 kilogauss. The authors find for crystals with axis perpendicular to the field a result analogous to that got by Becquerel with the axis parallel to the field. [See next Abstract.] J. J. S.

696. *Hall-effect and Change in Resistance in a Magnetic Field at Low Temperatures.* **B. Beckman.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 649–659, Nov. 28, 1912. Communication No. 130A from the Phys. Lab., Leiden.)—A continuation of previous accounts of researches [see two preceding Abstracts], the results being extended to the temperatures obtainable with liquid ethylene and liquid oxygen. The results obtained with Bi are discussed in the present communication and are given in a series of tables and curves. The change in the resistance of Bi was observed in eight different fields and at five different temperatures: 290°, 170°, 139·5°, 90°, and 72° abs. In the weaker fields the isotherms (showing increase of resistance as a function of the field at constant temperature) are convex towards the axis of abscissæ; from 12 kilogauss upwards they become straight. For $H > 12{,}000$ the relation $w'/w = a\mathrm{H} + b$ holds, where w' = resistance in the magnetic field and w = resistance without field and a and b are constants. At lower temperatures $a = a_0 e^{-\beta \mathrm{T}}$ to a first approximation. The behaviour as regards the Hall-effect varies in the case of different specimens of Bi. The results in certain experiments indicate the presence of impurity in the bismuth. At $\mathrm{T} = 289°$ the specific resistance of specimen $\mathrm{Bi}_{p\mathrm{I}}$ is about $1{\cdot}5 \times 10^5$ and for $\mathrm{Bi}_{p\mathrm{II}}$ $2{\cdot}3 \times 10^5$ C.G.S. The magnetic change of resistance is much smaller for $\mathrm{Bi}_{p\mathrm{II}}$ particularly at low temperatures. Just as in the experiments in liquid hydrogen, for $H > 3000$, RH becomes a linear function of the field $\mathrm{RH} = a'\mathrm{H} + b'$. Following J. Becquerel the Hall-effect may be regarded as resulting from two components: one proportional to the field and always negative for the plates used; the other constant (or saturated) for these plates ($\mathrm{Bi}_{p\mathrm{I}}$, $\mathrm{Bi}_{p\mathrm{II}}$) from $H = 3000$ upwards. In strong fields the constant R approaches a limiting value. In weak fields RH for $\mathrm{Bi}_{p\mathrm{I}}$ is inversely proportional to the temperature at $\mathrm{T} = 289°, 90°, 74{\cdot}5°$ abs. [See next Abstract.]

J. J. S.

697. *Hall-effect and Change in Resistance in a Magnetic Field at Low Temperatures.* **B. Beckman.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 659–663, Nov. 28, 1912. Communication No. 130B from the Phys. Lab., Leiden.)—This paper is a continuation of that dealt with in the preceding Abstract, and discusses the Hall-effect in the case of Au, Ag, Cu, and Pd at temperatures between + 17° C. and − 200° C., and also the behaviour of gold-silver alloys. From the observations made it appears that the Hall-coefficient for Au, Ag, and Pd is almost constant from ordinary temperatures down to that of liquid air. A distinct increase is noticed on proceeding to hydrogen temperatures which amounts to 25–35 % for Au, Ag, and Ca, and 100 % in the case of Pd. For an alloy of Au-Ag containing 2 % Ag by volume the Hall-coefficient was found to be almost constant. On proceeding to low temperatures it begins to show a slight decrease.

J. J. S.

698. *Hall-effect for Alloys at the Boiling-point of Hydrogen and at Lower Temperatures.* **H. Kamerlingh Onnes** and **B. Beckman.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 664–666, Nov. 28, 1912. Communication No. 130C from the Phys. Lab., Leiden.)—Measurements on two Au-Ag alloys containing greater percentages of silver than in the case described in the preceding Abstract are described. One alloy contained

10·6 atom. per cent. of silver. The thickness of the plate was 0·049 mm., and the Hall-effect was measured at temperatures 290°, 20·3°, and 14·5° abs. The ratio of the resistance without field at the temperatures mentioned to the resistance at 0° C. without field is at the three temperatures 1·08, 0·585, and 0·58. The Hall-coefficient R changes with the percentage of silver in the alloy. $R_{T=20}/R_{T=290}$ diminishes for greater percentages of Ag. For pure gold $R_{T=20·3} > R_{T=290}$, but for alloys with more than 2 % Ag by volume $R_{T=20·3} < R_{T=290}$. The curve that represents the relation between the Hall-coefficient $R_{T=20·3}$ and the percentage of silver is of a shape analogous to that representing the conductibility or the temperature coefficient of the resistance as a function of percentages of Ag. The curve for $R_{T=20·3}$ at first descends very rapidly for small admixtures of Ag; at higher concentrations it becomes flatter. The Hall-coefficient $R_{T=20·3}$ is approximately a linear function of the quantity $W_{T=20·3}/W_{T=273}$ for alloys with less than about 8 % by volume of Ag. The Hall-coefficient $R_{T=290}$ diminishes also though much more slowly than $R_{T=20·3}$ when the percentage of Ag increases. J. J. S.

699. *Susceptibility of Iron, Steel, Nickel, and Cobalt at High Temperatures.* **K. Honda** and **H. Takagi.** (Mathematico-Physical Soc., Tōkyō, Proc. 6. 22. pp. 314–325, Dec., 1912.)—In view of the importance, for the magneton theory, of the susceptibility of ferromagnetic substances at high temperatures, the testing of these was repeated to find whether the inverse proportionality of susceptibility to absolute temperature was exact. The Curie method was employed as on a former occasion, tests being carried out up to 1300° C. For nickel, the Curie law holds throughout a wide range of temperature, but deviations from the law were observed below 500° C. No discontinuity in the $1/\chi - t$ curve was noted at 900°. The law does not hold so well in cobalt as in nickel. Below 1240° the $1/\chi - t$ curve is convex to the temperature axis, but straight at higher temperatures. The law is only approximate for β iron and for steel with 14 per cent. of carbon when in the β state; it does not hold at all for γ iron or for steel in the γ region. With steel in the β region, increase of carbon causes increase of deviation from the Curie law. [See also Abstracts Nos. 581 (1911), 1111 (1912), 516 (1913).] G. E. A.

700. *Polar Armatures.* **H. du Bois.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 330–336, Oct. 24, 1912. Communication from the Bosscha Laboratory.)—The field due to ferromagnetic pole-pieces is only known for particular points in a few special cases: the author has therefore developed a more general and complete theory for arbitrary points in the field, regard being paid also to protruding frontal surfaces. Equations for prismatic pole-pieces as well as truncated cones have been calculated and the formulæ for round and prismatic armatures in special cases are discussed. J. J. S.

701. *Sun-spots and Terrestrial Magnetic Phenomena.* **A. L. Cortie.** (Roy. Astronom. Soc., M.N. 73. pp. 52–60, Nov., 1912.)—From an examination of the data for the period 1898–1911 it is shown that the cause of the inequality in frequency of magnetic disturbances is the inclination of the sun's axis to the plane of the equator, and the position of the earth relative to the sun-spot zones. It is also found that the magnetic storms in the period under discussion were more prolific in those years in which the mean daily area of spots was greater in the southern than in the northern hemisphere of the sun. C. P. B.

702. *Measurements of Terrestrial Magnetism, Atmospheric Electricity, and Light Intensity during the Solar Eclipse of April* 17, 1912. **W. Kolhörster.** (Deutsch. Phys. Gesell., Verh. 14. 16. pp. 812–826, Aug. 30, 1912.)—The observations were made at the Physical Institute of Halle in Saxony. The magnetic records for the 17th when compared with those for the 16th and the 18th show that the declination was slightly lower than usual during the eclipse, while before and after the eclipse it was normal. The horizontal force was slightly higher during the time of eclipse than on the 16th and 18th. The observed values of electrical dissipation were lower during the eclipse than before and after it, and also lower than on the 16th and 18th, but the difference is not sufficiently great to allow any direct influence to be traced. Measurements of the sun's brightness were made electrically. The graph showing the results exhibits a gradual fall from the commencement of the eclipse to the time of max. phase when only 3·65 per cent. of the original brightness was recorded. R. C

703. *Theory of Magnetism.* **H. A. Lorentz.** (Archives Musée Teyler, 1. Ser. 3. pp. 75–86, 1912.)—A short review of the present state of the electronic theory of magnetism in which the chief conclusions arrived at, from the consideration of the work of Curie, Langevin, Weiss, and others, are set forth. G. E. A.

704. *Molecular Magnetism.* **P. Weiss.** (Archives des Science, 34. pp. 197–215, Sept., 1912.)—A popular account of the magneton theory. [See Abstract No. 222 (1912).]

705. *Mutual Action of Two Magnets placed in any Position.* **A. Schmidt.** Terrestrial Magnetism, 17. pp. 181–232, Dec., 1912.)

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

706. *Chemical Reactions of β-Gold and Crystalline Gold.* **M. Hanriot** and **F. Raoult.** (Comptes Rendus, 155. pp. 1085–1088, Nov. 25, 1912.)—Brown gold [Abstracts Nos. 551 and 968 (1911)] is much more soluble than ordinary yellow gold in nitric and hydrochloric acids, the solubility in the latter being much greater in an atmosphere of oxygen than in CO_2. Brown gold is slightly soluble in $AuCl_3$, and very much more soluble in hot $AuCl_3$ containing 25 per cent. of HCl gas. Such a solution, on cooling, deposits crystals of gold, which from their magnetic susceptibility evidently consist entirely of β-gold. Hence solution in hot $AuCl_3$ containing HCl gas is a means of separating the α and β varieties of brown gold. W. H. St.

707. *Active Nitrogen.* **F. Comte.** (Phys. Zeitschr. 14. pp. 74–76, Jan. 15, 1913.)—Quotes some experiments which go to show that "chemically active nitrogen" [Abstracts Nos. 93 (1906), 1897 (1912)] requires for its manifestation the presence of a trace of oxygen. On passing commercial compressed nitrogen successively through water, soda-lime, calcium chloride, hot copper dust, and phosphorus pentoxide the cloudy luminiscence described by Strutt appeared at first under the influence of an electric discharge, but gradually decreased, ceasing after the nitrogen had been passed for 3 to 4 hours. On mixing a little air with the nitrogen the luminosity returned. The amount of oxygen required was too small to be determined. E. E. F.

708. *Radio-active Elements and the Periodic System.* **A. van den Broek.** (Phys. Zeitschr. 14. pp. 32–41, Jan. 1, 1913.)—Since it is found that no radio-active element emits more than one α-particle, and that several of them (U, RaC, and ThB) can give rise to two subsequent series, the number of products to be arranged in the periodic system is 14 for the Ra and Th families, and 5 for the Ac family. No products are considered to be separate elements unless they have different atom weights, the expulsion of β-particles not constituting a transmutation. Out of the 14, the 5 descendants of Ra and Th emanations may be placed in groups 6, 7, and 8. For the two emanations, for radiothorium, and ionium, however, we must assume that they form a complex group, like group 8 generally. Then the mean successive difference in atomic weight becomes 2 for the whole system, and the intra-atomic charge is half the atomic weight. With every step the valency increases by one unit, and when the valency reaches 8 the valency bonds are probably arranged in a tetrahedral or cubical manner, with successive concentric shells for the higher series. E. E. F.

709. *Valency of the Radio-active Elements.* **G. v. Hevesy.** (Phys. Zeitschr. 14. pp. 49–62, Jan. 15, 1913.)—The valency was determined by observing the velocity of diffusion of kathions in a large excess of their anions, the constant of diffusion being $1{\cdot}25/n$ cm.^{2}/day, when n is the valency. The method was that of Graham and Stephan, and the apparatus resembled Scheffer's. $RaCl_2$, diffusing into 0·01-nHCl, gave a valency of 2. Uranium I. and Ur II. are sexavalent, UrX, ionium, thorium, radiothorium, and

radioactinium are quadrivalent; the emanations have no valency, and the remaining elements are univalent or bivalent. The method was controlled by a determination of the mobility of the same ions, and Nernst's formula for the diffusion coefficient $D_{18} = 0{\cdot}04485/n \,.\, u/v(u + v)$ was confirmed for all valencies. The connection between the mobility of the ion and its position in the periodic system indicates that ThB, RaB, and AcB give univalent ions in solutions, but are not alkali metals, and should be placed between Pb and Tl. It appears that an expulsion of an α-particle changes the valency by two units, and makes the ion more electro-positive. The contrary change is produced by the expulsion of β-particles. The expulsion of α-particles is similar in its effects to the reduction in the valency of a multivalent metallic kathion. This also enhances the electro-positive character of the element. E. E. F.

710. *Sodium as a Member of a Radio-active Series.* **F. C. Brown.** (Le Radium, 9. pp. 352–355, Oct., 1912. Science, 37. pp. 72–75, Jan. 10, 1913.)—Sodium is generally considered as non-radio-active, since no observers have been able to detect any ionising radiation from it. In the present paper, however, the author advances the view that there is evidence of its radioactive nature from geological considerations. Assuming that the salinity of the ocean is due to the salt taken to it by the water of rivers, Joly has calculated the age of the earth to be about 7×10^7 years. From the He-, Pb-, and Ur-content of rocks, however, a minimum estimate of about 6 times this period is obtained. Accepting the latter estimate, it follows either that there is too little NaCl in the ocean, or too much in water of rivers at the present time. The author advances the supposition that the NaCl-content of rivers is high because sodium is being produced by disintegration of some substance present on the land only. Evidence in support of this idea is also presumed from the fact that river waters contain a large excess of sodium relative to chlorine, while in the ocean the reverse holds. E. M.

711. *Heating Effect of Radium.* **V. F. Hess.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 1419–1427, July, 1912. Communication from the Inst. f. Radiumforschung.)—The author has made measurements, using the radium purified by Hönigschmid and the apparatus of Meyer and Hess [Abstract No. 546 (1912)]. The radium salt, 570·10 mgm. $RaCl_2$, was crystallised from an acid solution, dried, and introduced into the calorimeter, and the rise of the heating effect observed over a period of several days. The observations were found to agree well with the theoretical formula $Q_t = Q_{Ra} + Q_E\,(1 - \epsilon^{-\lambda t})$, where Qt, Q_{Ra}, and Q_E are the heat evolution of the whole, the radium itself and the emanation respectively and λ is the transformation constant of RaEm. The values deduced for Q_{Ra} and Q_E are 25·2 and 107·1 gm. cals. per hour respectively, giving a total of 132·3. Q_E includes the products as far as RaC in their equilibrium amounts. In the experiments all the α- and β-rays were absorbed and 18 % of the γ-rays. Assuming that all the heating effect of the radium without its products, is due to the kinetic energies of the α-particles and the recoil atoms the velocity of the former is deduced to be $1{\cdot}595 \times 10^9$ cm./sec. E. M.

712. *Laws of Surface Adsorption and the Potential of Molecular Attraction.* **J. R. Katz.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 445–454, Nov. 28, 1912.)—Experiments are described on the adsorption of water by finely-divided synthetic quartz and synthetic anorthite. The substance was

first left for some days in air which was in contact with 1 per cent. sulphuric acid solution, and was then allowed to reach a constant weight over aqueous sulphuric acid solutions of known vapour pressures; the adsorbed water was determined by igniting the substance. Curves connecting the adsorbed water as abscissæ with the relative vapour pressure, p/p_0 (where p_0 refers to pure water), are at first nearly horizontal, then nearly vertical, and finally nearly horizontal again. This characteristic form is regarded as related to the variation of the vapour pressure with the thickness of the film of water on the surface of the substance. The vapour pressure p and the potential of the molecular forces k are related according to the expression, $k = \mathrm{RT} ln p/p_0$, and application of this to the data obtained shows that the potential of molecular attraction diminishes rapidly as the thickness of the water-film increases, and that there exists a sphere of attraction which is moderately well defined, and which has the radius $1{\cdot}3 \times 10^{-6}$ cm. and $6{\cdot}2 \times 10^{-6}$ cm. for water on the surface of quartz and anorthite respectively. There is here no apparent relation to the density of the solid, but it seems that substances with many atoms in the molecule have a larger radius. T. H. P.

713. *Action of Ultra-violet Light on Water.* **W. Obolensky.** (Ann. d. Physik, 39. 5. pp. 961–975, Dec. 5, 1912.)—Extreme ultra-violet rays act upon pure water so as to produce a photoelectric effect comparable with the effect upon copper oxide and other materials. The source of light used was the spark between Al electrodes, which emits effective rays of wave-lengths of approximately 185 and 130 μμ. The latter group is cut off by a quartz plate 25 μμ thick. The 185 group was then weakened by extending the gap between the spark and the water surface from 3 mm. to 10 mm. All light below 204 μμ was cut off by a calcspar plate 3 mm. thick, and finally glass was interposed, which transmits only a small fraction of ultra-violet light. The shortest wave-length was found to be the most effective, the effect observed being $\frac{1}{400}$th of that in cupric oxide. The effect in water disappears at 202 μμ. Slight impurities make no difference, but the addition of considerable quantities of chlorides reduces the photoelectric discharge, whereas sulphates, carbonates, and nitrates increase it. Ice shows an effect of the same order as cupric oxide, and so does hoarfrost. No effect of meteorological importance can be attributed to the action on water. But cirrus clouds, if composed of ice crystals, may well be electrically charged, as was assumed by Brillouin. E. E. F.

714. *Action of Ultra-violet Light on o-, m-, and p-Nitrobenzaldehyde and on Benzaldehyde.* **A. Kailan.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 1329–1351, July, 1912.)—The bodies are dissolved in benzene or in alcohol, and radiated upon by a quartz mercury lamp for 10 or 15 mins. in vessels of quartz or of glass; the effects are stronger in the quartz vessels, and the glass turns brown. The aldehydes are oxidised to benzoic acid, similarly as by penetrating radium rays [see Abstract No. 598 (1912)] but much more rapidly, especially in benzene solutions. The velocity of the reaction increases with the concentration, but at a smaller than the proportionate rate; when the distance between lamp and solution is increased, the rate decreases less rapidly than it should according to the law of inverse squares. There is a considerable absorption of the rays by the solutions. The temperature coefficients are very small, as with all photochemical reactions. The oxidation seems to be due to the oxygen of the air or the ozone formed. Some of the solid substances are hardly affected. H. B.

715. *Action of the Penetrating (β and γ) Radium Rays.* III. *Action on Inorganic Compounds.* **A. Kailan.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 1358–1384, July, 1912.)—The arrangements were as in previous experiments, the radium-barium chloride used containing in different tests up to 80·5 mgm. of metallic Ra. Ferric sulphate is reduced, especially in the presence of sucrose, the rate being more than twice as rapid as the formation of H_2O_2 (during the same period) from neutral water. This hydrogen peroxide is formed by the radiation from acid, neutral and alkaline water, the velocity of the reaction decreasing in the order stated. Potassium bromide is decomposed under liberation of bromine when dissolved in sulphuric acid; the rate hardly increases when the concentration of the salt or acid is increased, but is only a fraction ($\frac{1}{20}$ to $\frac{1}{100}$) of the rate of decomposition of potassium iodide, if the action of any H_2O_2 possibly formed be neglected; potassium chloride is not decomposed. H. B.

716. *Action of the Penetrating (β and γ) Radium Rays.* IV. *Action on Organic Compounds and Reactions.* **A. Kailan.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 1385–1401, July, 1912.)—The velocity of the esterification of benzoic acid (if dissolved in absolute or aqueous alcohol) is catalytically accelerated by the presence of hydrochloric acid, but not affected by the radiation, from which it would follow that the radiation does not influence the dissociation of alcoholic hydrochloric acid either. The formation of a benzoic acid derivative from orthonitrobenzaldehyde is accelerated by the radiation (in alcoholic and in benzene solutions), but 90 mgm. of radium chloride have only $\frac{1}{10000}$ or $\frac{1}{20000}$ the effect of a quartz mercury lamp at 8 cm. distance, and the velocity of the reaction hardly increases with increasing concentration of the aldehyde. Quinone, which is easily decomposed by blue and violet rays, is not affected by the rays in ethereal or in alcoholic solution, nor did the rays accelerate the light effect. Oxalic acid is not changed at 25° by the rays after 1000 hours by 200 mgm. of salt. The rate of the inversion of unsterilised solutions of sucrose is accelerated by the rays, but strangely enough the growth of mould seems to be favoured by the rays. H. B.

717. *Sunlight.* **P. C. Freer and H. D. Gibbs.** (Journ. Phys. Chem. 16. pp. 709–738, Dec., 1912. Paper read before the 8th Internat. Congress of Applied Chemistry, N.Y., Sept., 1912.)—The supposed superiority in the influence of sunlight on chemical and physiological processes in the tropics over that shown in the temperate zone has been investigated by studying the photochemical action of tropical sunlight. No definite conclusion is possible from the examination of the effect of sunlight on the colouration of various benzene derivatives. The decomposition of oxalic acid in presence of uranyl acetate, which has a very low temperature-coefficient, was taken as a measure of the intensity of violet and ultra-violet radiation. Comparison of the average amounts of oxalic acid decomposed per hour throughout the year at various places shows lower figures for the higher latitudes; this is attributed to the lower proportion of clear days in these latitudes, since with a clear sky the activity is almost the same everywhere. The influence of tropical sunlight on animals and human beings was also investigated. T. H. P.

718. *Diffusion of Uranium.* **G. v. Hevesy** and **L. v. Putnoky.** (Phys. Zeitschr. 14. pp. 63–65, Jan. 15, 1913.)—An attempt was made to separate

Ur I. from Ur II. by diffusion, but without success. If there are two such substances, as is made probable by the work of Boltwood [Abstract No. 1100 (1908)], Marsden and Barratt [Abstract No. 1348 (1911), and Geiger and Nuttall, they must be chemically very similar. The most probable disintegration scheme is Ur I. $\longrightarrow$ UrX $\longrightarrow$ Ur II. $\longrightarrow$ Io $\longrightarrow$ Ra.

E. E. F.

719. *Volume-changes of Amalgams.* **J. Würschmidt.** I. (Deutsch. Phys. Gesell., Verh. 14. 23. pp. 1065–1087, Dec. 15, 1912.)—The author has investigated the change of volume with temperature of a series of amalgams, by a dilatometric method, a special dilatometer, suitable for the purpose being described. He finds that the amalgams of tin, lead, and cadmium, which according to Puschin are to be regarded as solid solutions, exhibit at the melting-point a very clearly marked maximum of the expansion coefficient, whereas the zinc amalgams, which are to be regarded as "mechanical mixtures," exhibit this maximum at a temperature considerably below the melting-point. In the case of sodium amalgams, a peculiar behaviour is found, namely, changes of volume occur with time, even at constant temperature, and moreover, the melting-point and freezing-point do not coincide.

A. F.

720. *Alloys of Cobalt with Chromium, etc.* **E. Haynes.** (Amer. Inst. of Mining Engin., Bull. No. 74. pp. 249–253; Discussion, pp. 253–255, Feb., 1913. Metallurgical and Chem. Engin. 10. pp. 804–806, Dec., 1912. Abstract. Mech. Eng. 30. pp. 819–820, Dec. 27, 1912.)—Using an alloy of cobalt with 15 % chromium as basis it has been found that tungsten increases the hardness until at 10–25 % the ternary alloy can be used for cutting tools. At 40 % tungsten the alloy will cut glass and scratch quartz. Molybdenum acts in the same way. The presence of carbon, silicon, and boron still further hardens the alloys, but also renders them brittle. All the alloys resist atmospheric influences remarkably well. F. C. A. H. L.

721. *The System Tin.* **A. Smits** and **H. L. de Leeuw.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 676–681, Dec. 30, 1912.)—The fact that tin exists in two crystalline forms, viz. the tetragonal having a sp. gr. of 7·25 and the rhombic with a sp. gr. of 6·55, in conjunction with the appearance of brittleness at 200° C. indicates the existence of a transition-point at about this temperatures. Dilatometric experiments using a non-volatile oil as liquid show that a slow transformation takes place at 200·8° C. Above this temperature expansion occurs, and below it contraction, while at 200·8° C. no change in volume takes place even after 4 days. The presence of mercury rapidly lowers the temperature of transition which accounts for Degens' low value for this point. Using mercury as the liquid in a dilatometer he observed the transition at 161° C. [See Abstract No. 1782 (1908).]

F. C. A. H. L.

722. *Correspondence on Exothermic Steel.* (Metallurgical and Chem. Engin. 10. pp. 712–713, Nov., and pp. 775–776, Dec., 1912.)—**J. W. Richards** casts considerable doubt on the process for making exothermic steel described in Abstract No. 136 (1913) and points out that the true formula for felspar is $KAlSi_3O_8$ and not $KAl_3Si_3O_8$ as stated by Amsler. **F. Gelsthorp** takes exception to the introduction of hydroxide into an equation representing a reaction taking place at a temperature above that at which all hydroxides are decomposed. **J. Härdén** describes an experiment in which 100 lbs.

tungsten ore, 182 lbs. felspar, 60 lbs. bauxite, 10 lbs. lime, 4 lbs. carbon, and 6 lbs. iron were melted down in an electric furnace. A cake of fused semi-metallic material weighing 59 lbs. and containing 29·5 lbs. tungsten resulted. Thus 48·2 per cent. of tungsten was lost in the slag. **W. O. Amsler** defends the process and says it is in commercial operation, steel made by it being supplied to the U.S. Government. The reaction is not so vigorous as the thermit reaction and must be supported by external heat. Härdén used far too much bauxite and felspar. F. C. A. H. L.

723. *Structure of Cast Iron and Effects of Superheated Steam.* **W. Campbell and J. Glassford.** (Rev. de Métallurgie, 9. pp. 1146–1158, Dec., 1912.)—It has been observed repeatedly that some cast irons, when subjected to the action of superheated steam, undergo a sort of corrosion which causes them to grow and become fragile, while others can be used for many years without showing any signs of corrosion. The authors have attempted to determine the nature of this corrosion, why it affects certain irons and not others, and how it can be reduced to a minimum. Microscopic examination of cast iron which had failed under the action of steam at 427° to 482° C. after about 2 years indicated that silico-ferrite is the most rapidly attacked constituent while cementite is the most stable. The mechanism of the action appears to be that the graphite plates first become surrounded by a thin film of oxide which is gradually added to until a complete network of oxide+graphite is formed, when the material becomes extremely fragile. Numerous varieties of steel, also grey, white, and malleable cast-iron have been subjected to the action of superheated steam at 425° C. for periods of 30 and 90 days. The results of subsequent determinations of changes in size and weight, and microscopic observations show that white cast-iron, steel, and malleable cast-iron become covered with a skin of oxide which fills all the cracks, etc. Grey cast-iron containing about 0·95 % Si shows a similar superficial oxidation, but in addition there is a slow penetration of oxide following the larger plates of graphite. This penetration increases with the content of Si and a new white constituent is precipitated round the oxidised areas. At 5·5 % Si the structure is completely altered. The corrosion appears to diminish with the fineness of the graphite plates. Repeated heatings and coolings (72) to and from 425° C. in the air only resulted in superficial oxidation. F. C. A. H. L.

724. *Modifications of Iron below* 700° *C.* **F. Robin.** (Rev. de Métallurgie, 9. pp. 1083–1085, Dec., 1912.)—The author gives a list of the points of singularity revealed in iron up to 700° C. A review of the evidence based on mechanical, magnetic, thermoelectric, and sonority tests made by numerous workers, points to the existence of two allotropic changes in iron, one between 100 and 250° C., and the other between 400 and 500° C. F. C. A. H. L.

725. *Slag Enclosures.* **W. Rosenhain.** (Rev. de Métallurgie, 9. pp. 998–1014, Dec., 1912.)—Under the term "slag enclosures" the author includes all fluid or semi-fluid substances which would be expelled from the steel during solidification and cooling under favourable conditions. Objection is taken to Hibbard's suggestion of "sonim" for the "solid non-metallic impurities in steel because of the introduction of a new term into the literature of a subject already overburdened with names, and because of the difficulty in deciding which are metallic and which non-metallic impurities. The researches of Matweieff and Levy are discussed, and it is suggested that the iron and manganese sulphides series and the iron and manganese silicates should be further studied, particularly as regards their solubility in iron. The mode of formation of the slag enclosures is not sufficiently well understood to permit of the formulation of definite rules for their elimination. They probably exist in minute globules in the molten steel, and steps should be taken to cause these globules to coalesce into larger ones which should then be given time to rise to the surface. With regard to the mechanical effect of the enclosures Ziegler has expressed the opinion that they form nuclei for the crystallisation of α-iron from austenite [see Abstract No. 766 (1912)], and while it is generally accepted that the presence of slag is a determining factor in the brittleness of steel, further research on this point is advisable. F. C. A. H. L.

726. *Biography of Pro-eutectoid Cementite.* **H. M. Howe** and **A. G. Levy.** (Rev. de Métallurgie, 9. pp. 1075–1082, Dec., 1912.)—The zone between the austenite region and the Ar_1 line in the iron-carbon equilibrium diagram is called the "zone of transformation," and the cementite and ferrite generated in this zone are designated "pro-eutectoid" to distinguish them from pearlitic cementite and ferrite. A study of the pro-eutectoid cementite in hyper-eutectoid steel has been made by heating steels to temperatures between 1000° and 1300° C. and quenching after cooling to various temperatures between 700° and 960° C. and in other cases after maintaining at 800° C. for various periods of time. In every case the samples were subsequently tempered at 400° C. to facilitate cutting and to accentuate the contrast between the cementite and the ground-mass. In the zone of transformation the precipitation of cementite, like ferrite, appears to be rapid, but the rate of agglomeration is very slow. With decrease of temperature or increase of carbon-content the rate of agglomeration increases. Apparently the internal cementite is transferred to the network by a kind of dissolution of the fine needles and subsequent sublimation to the larger masses forming the borders of the original austenite grains. There appear to be two forces at work on the internal cementite: the network of cementite tries to force its orientation at the moment of formation or of reprecipitation, and the austenite tries to force the cementite into its cleavage planes at the moment of formation. Sometimes one action predominates, in other cases the other force prevails. The growth of grain-size is very much more rapid at 1200° or 1300° than at 1000° C. Increase of carbon also increases the rate of grain growth, although the presence of excess of internal cementite frequently masks this effect. F. C. A. H. L.

727. *Uniform Nomenclature for Iron and Steel.* **H. M. Howe** and **A. Sauveur.** (Rev. de Métallurgie, 9. pp. 1043–1064, Dec., 1912.)—The report of the Commission appointed by the 5th International Congress for Testing Materials to solve the above problem was favourably received. Some of the definitions have been modified and additional ones added. In the opinion of the majority of the members there is room for radical alteration in the terms "blister steel" and "malleable cast iron." Unlike the other steels, blister steel has not been cast from the liquid state, but has been produced in a plastic condition, while the essential property of malleable cast iron, viz. malleability, is totally absent in all other varieties of cast iron. It is proposed therefore to remove blister, shear, and double-shear steels from the general class of steels and malleable cast iron from the class of cast iron, and to bestow upon these materials new and distinctive names.

The English members of the Commission strongly oppose these proposals on the grounds that the Commission was not appointed to introduce new terms, but to define clearly the existing ones. Blister Steel and Malleable Cast Iron have been so well known for so long a period that any change in their description is bound to lead to confusion. F. C. A. H. L.

728. *Nomenclature of the Micro-constituents and the Micro-structures of Steel and Cast Iron.* **H. M. Howe** and **A. Sauveur.** (Rev. de Métallurgie, 9. pp. 983–997, Dec., 1912. Report to the Internat. Assoc. for Testing Materials.)—This is the report of the Commission appointed by the above Association, and is a continuation of the work described in Abstract No. 1032 (1910). Division into metarals and aggregates is adhered to, and the plan followed has been to consider only generally accepted principles and theories. First there is the liquid iron, which forms austenite, cementite, and graphite during solidification. During the transformation of austenite, martensite, troostite, and sorbite are formed as intermediate products; the final products being ferrite and pearlite. Other and rarer constituents are: ledeburite (Wüst)—the austenite-cementite eutectic, ferronite (Benedicks)—iron containing about 0·27 % of carbon, steadite (Sauveur)—the iron-iron phosphide eutectic, and the three transition products hardenite (Arnold), osmondite (Heyn), and troosto-sorbite (Kourbatoff). The latter is falling into disuse, while osmondite is described as the limiting phase between troostite and sorbite. Each of these constituents is fully described, its name being given in English, French, and German, and other titles are indicated if any such exist. Manganese sulphide is also included as a micro-constituent of steel. It is considered that the terms saturated, super-saturated, and non-saturated steels are liable to lead to errors, and should therefore be dropped in favour of the terms eutectoid, hyper-eutectoid, and hypo-eutectoid. F. C. A. H. L.

729. *Influence of Geometrical Shape on Chemical Action.* **G. Reboul.** (Comptes Rendus, 155. pp. 1227–1229, Dec. 9, 1912.)—A small plate of copper was introduced into a very high vacuum by attaching it to an iron support floating on mercury, and raising the level of the mercury until the copper was inside the large vessel. The iron support also held a piece of vulcanised rubber, which slowly emits sulphur vapour. The vapour gradually blackened the copper, but the blackening commenced at the edges, and reached the centre of the surface last. The position of the plate was immaterial. The velocity of reaction increases with the curvature of the surface. An ellipsoid is first attacked at the two ends. When two copper spheres are placed close to each other, and exposed to sulphur vapour, the smaller sphere is blackened first. Care must be taken to avoid turbulence in the attacking gas, hence the precaution of using vulcanised rubber. E. E. F.

730. *Spontaneous Variations of Concentration.* **T. Svedberg.** (Phys. Zeitschr. 14. pp. 22–26, Jan. 1, 1913.)—The relative mean deviation from the mean concentration of molecules in a given volume of liquid or gas is $\surd(1/\nu)$, where ν is the mean number of molecules in the volume. The author discusses the methods by which such variations of concentration might be discovered. Radio-active bodies, whose individual atoms can be observed at the moment of disintegration, appear to offer the best facilities. The probability of disintegration is the same as the probability of concentration, so that the total deviation from the mean should be $\surd(2/\nu)$. Some experiments made with Ra emanation and polonium solutions (to be fully described shortly)

appear to confirm this. Since 1910 the author has made numerous attempts to observe similar deviations in other molecules, notably in fluorescent substances. Rhodamin can be perceived by dark-ground illumination when the concentration is as low as 10^{-7} normal. This gives 60 molecules per cubic micron, and a spontaneous variation of 13 per cent. should be observable. But nothing of the kind was seen. If the emission of light by the fluorescent molecules is by quanta, these flashes would be much more numerous than the molecules, and, emanating from molecules in rapid motion, might mask the effect sought. E. E. F.

731. *Dielectric Constants of Dissolved Salts.* II. **P. Walden.** (Acad. Sci. St. Pétersbourg, Bull. 18. pp. 1055–1086, Dec. 15, 1912.)—Investigations similar to those previously made with chloroform solutions [Abstract No. 924 (1912)] have been carried out with solutions in dichloromethane (dielectric constant, 8·3) and in ethyl formate (8·2), which differ from chloroform in giving measurable ionic dissociation of the salts employed (*loc. cit.*); further, ethyl formate being a solvent of an entirely different type, its use opens up the possibility of studying the chemical rôle of the atoms constituting the solvent. As with chloroform, so also with dichloromethane, the dissolution of the salts is accompanied by considerable increase in the dielectric constant of the solvent. Further, these constants for the salts, calculated by Philip's, Bouty's, and Silberstein's formulæ, are mostly very high, the greatest values being obtained with the first of these formulæ. In dichloromethane, the value of the constant for any salt is much higher than in chloroform. This constant also increases with the complexity of the salt and, according to Philip's formulæ, has the values; $NH(C_2H_5)_2,HCl$, 88; $N(C_2H_5)_3,HCl$, 390 and $N(C_2H_5)_4,Cl$, 1980. For any one salt at equal dilutions, the molecular conductivity is from 10 to 30 times as great in dichloromethane as in chloroform and, whilst in the latter solvent it diminishes rapidly and continuously as dilution increases, in the former a minimum is observed at a certain dilution. It is concluded that the ions formed from the salt are able to raise the dielectric constant of the solution and also the dissociating power of the solvent. Ebullioscopic measurements show that the salts have different molecular magnitudes in the two solvents, these being, for $N(C_2H_5)_4Cl$, M_6 in chloroform and M_2 in dichloromethane and for $N(C_2H_5)_3$, HCl, M_2 and M_1—M_2 respectively. The chemical process of salt formation by the conjunction of the two neutral constituents [$N(C_2H_5)_3 + C_2H_5Br$, &c.] is expressed physically in a reconstruction of the dielectric properties of these constituents in such a way that the new product shows a dielectric constant about 6, 13, or 18 times that calculated additively for secondary amine, tertiary amine, and tetralkylammonium salts respectively. Calculation by means of the Clausius-Mosotti equation, $x = (K - 1)/(K + 2)$, where x represents the fraction of the total volume actually occupied by the molecules, shows that those salts are the best electrolytes for which x approaches the value 1. Not only is the general behaviour of ethyl formate as regards the alteration of the dielectric constants of dissolved alkylamino-salts similar to that of dichloromethane, but the actual values of these constants are very nearly equal with the two solvents. Sodium iodide and lithium bromide are characterised by extremely high dielectric constants in ethyl formate—5595–6820 and 4760–5300 respectively, according to Philip's formula; calcium iodide shows a much smaller value (1540) and mercuric chloride one still smaller (490). Thus, the dielectric constant of these salts diminishes with their capacity to dissociate. Results obtained with solutions of salts in the strongly-ionising solvents, acetone,

acetylacetone, acetonitrile, and propionitrile, confirm the conclusion that, if the dielectric constant of the medium remains constant, the formation of ions increases the ionising tendency and the degree of electrolytic dissociation of the salt. Certain anomalies exhibited by solutions are discussed in connection with the increases produced in the dielectric constants and hence in the ionising power of solvents by the dissolution of electrolytes. It is pointed out that this phenomenon must be taken into account in considering deviations from the law of mass action (Ostwald's dilution law), the rôle of neutral salts, the disagreement of salts dissolved in media having feeble ionising actions with the requirements of the theory of Arrhenius, etc., since by it, as well as by the other well-known factors, the degree of electrolytic dissociation is appreciably altered. T. H. P.

732. *The Wet Oxidation of Metals.* II. *The Rusting of Iron* (*continued*). **B. Lambert.** (Chem. Soc., Journ. 101. pp. 2056–2075, Oct., 1912.)—The experiments of Moody and Friend prove only that passive iron may be kept from corrosion in contact with water and air in the absence of acid constituents, their samples having been previously rendered passive by treatment with chromic acid and caustic soda respectively. Extraordinary precautions have been taken to prepare pure oxygen and pure water by electrolysis and distillation of solutions of chemically pure barium hydroxide in conductivity water. The water was distilled on to the iron contained in a quartz tube and the presence of CO_2 was tested for repeatedly by means of a Plücker tube. In spite of all these precautions, rusting took place in three commercial forms of iron, apparently as quickly as in ordinary water and air or oxygen. A pure metal is scarcely affected by electrolytes, but in contact with a more electronegative metal it dissolves and generates a current flowing through the electrolyte from the electro-positive to the electro-negative pole. The rate of reaction, or the amount of current flowing, depends upon the difference of solution pressure between the two metals or modifications of the same metal and upon the resistance of the electrolyte. Commercial iron is non-homogeneous, so that all the conditions for the production of an electric current exist when the metal is immersed in electrolyte water. In the absence of oxygen, solution is infinitely slow owing to the small differences of potential between the different parts of the metal and the great resistance of the pure water. Rusting takes place, however, in the presence of oxygen, and since solution must necessarily precede rusting, it follows that oxygen must either reduce the resistance of the water or increase the differences of solution pressure between the various parts of the metal. Pure iron prepared by the author has been kept in contact with pure water and pure oxygen for over two years without showing any visible signs of rusting. If a piece be removed and locally deformed, signs of corrosion appear after 1 hour's immersion. Immersion of other samples of the pure iron in a normal solution of salt resulted in rusting even after a few hours. That constituents of the air other than oxygen, play little or no part in the process is shown by the fact that rusting is just as rapid in pure oxygen. Sulphuric acid, nitric acid, sulphates, and nitrates have much less action on pure iron than hydrochloric acid and chlorides. Pure iron will withstand the action of saturated copper sulphate and nitrate solutions for an indefinite period, but local deformation results in the immediate deposition of copper. In copper chloride solution copper is immediately deposited. The protective action is not due to the formation of oxides, but to the fact that certain materials reduce the differences of potential existing in all commercial irons. Passive irons therefore possess an "electrically equable surface." The author's pure iron does not give rise to positive and negative nodes in the ferroxyl reagent, except after local deformation, when the part deformed goes into solution and generates the blue zone. It seems probable, therefore, that the fundamental cause of the rusting of iron is not carbonic acid, but is to be sought in differences of solution pressure between different parts of the metal. F. C. A. H. L.

733. *Action of Electrolytes on Metals subjected to Stresses.* **H. Baucke.** (Rev. de Métallurgie, 9. pp. 1154–1159, Dec., 1912.)—Recent electrochemical researches on corrosion have revealed differences of potential between electrodes of the same metal subjected to different thermal or mechanical treatments. The metastable metal always becomes the anode, and it would appear that contact with an electrolyte should accelerate the reversion of the metastable to the stable form. It has been observed by the author that steel balls (used for bearings) which frequently break in service, reveal the existence of crevices after etching with alcoholic hydrochloric acid. These fissures exist internally as well as externally, and under high magnifications show an undulating appearance at the edges. They are not directly produced by the etching, but during hardening local contractions are set up, and these give rise to superficial folding followed by the development of fissures. The system of heating boiler-plates frequently results in the development of cracks even in very pure materials. Wrought iron shows less tendency to crack so that the fault cannot be attributed to slag. The fissures are the outcome of deformation and the subsequent tendency of the material to revert to its stable state. In both cases the fissures are revealed by contact with an electrolyte which apparently accelerates the conversion of the amorphous material produced by hardening contractions in the case of the balls, and by deformation in the case of the plates into the stable form.

F. C. A. H. L.

734. *Properties of Fused Carnallite.* **K. Arndt** and **H. H. Kunze.** (Zeitschr. Elektrochem. 18. pp. 994–998, Nov. 15, 1912. H. H. Kunze's Dissertation, Berlin, 1912.)—An artificial carnallite (raw material for the magnesium electrolysis) was prepared by mixing KCl and $MgCl_2$, adding some NH_4Cl to prevent the decomposition of the fused $MgCl_2$. The freezing-point of theoretical carnallite is 496° ; by further adding from 36 to 30 per cent. of KCl the freezing-point was lowered to 493° and finally to 486°, but the curves were not regular. Density and conductivity (electric) measurements are also made between 550° and 780° ; comparative data for pure $MgCl_2$ could not be obtained, as it decomposed. The statement of A. Oettel (Dissertation, Dresden, 1908) that magnesium can, like calcium, be gained in stick-form when the kathode is slowly being lifted during the electrolysis is confirmed ; great care is needed, however. H. B.

735. *The Equation of State for Solids, and the Theory of Specific Heats.* **E. Rasch.** (Königl. Materialprüfungsamt, Mitt. 30. 5. and 6. pp. 320–348, 1912.)—In the present communication, which is stated to be of a preliminary character, the author criticises the equations of Einstein, Nernst, and Lindemann for the specific heats of solid substances. He points out that these equations, which are of a rather complex character, fail to express the experimental results because the assumption is falsely made that the upper value of the molecular heat (b_∞) is a universal constant, whereas, according to the author, it is a characteristic material constant, and has, in general, a greater value than that assigned to it by the Einstein-Nernst theory. In place of these equations the author deduces a set of much simpler equations which he expresses in the differential and integrated forms as follows:—

$$dQ = b_\infty e^{-\theta/T}\, dT\ ;\ c = c_\infty e^{-\theta/T}\ ;\ b = b_\infty e^{-\theta/T}\ ;$$

in which c and b are the specific and atomic (or molecular) heats respectively, e is the base of the natural logarithms, T is the absolute temperature, and θ is a characteristic constant for the material, and represents a definite temperature. By means of a number of experimental results the author shows how his equations are in accordance with the results of experiment. A. F.

736. *Heats of Dilution.* **W. F. Magie.** (Phys. Rev. 35. pp. 265–271, Oct., 1912.)—A study of the constants of the formula which represents the heat capacity of a solution shows that the number of degrees of freedom of the undissociated molecules of the solute and of the water affected by them is increased by solution, and that the number of degrees of freedom of the ions and of the water affected by them is always decreased. As dilution proceeds and the molecules break up into ions, the number of degrees of freedom of the solution diminishes both by the removal of molecules from the solution and by the introduction of new ions, the change in the number of degrees of freedom being proportional to the change in the amount of dissociation. At the temperatures now under consideration the energy associated with a degree of freedom is proportional to the absolute temperature. An evolution of heat proportional to the change in dissociation and to the absolute temperature is thus accounted for. T. M. L.

737. *Critical Coefficient and Molecular Weight of Substances at the Critical Point.* **A. Boutaric.** (Comptes Rendus, 155. pp. 1080–1082, Nov. 25, 1912.) —Guldberg showed that the absolute boiling-points of very varied liquids were in all cases about two-thirds of the absolute critical temperatures. Since the boiling-points are corresponding temperatures for all liquids, the volumes at the boiling-points should also correspond, *i.e.* v/ϕ should be constant, where v is the specific volume of a liquid at its boiling-point, and ϕ is the critical volume. Further, as van der Waals' theory shows that $\phi = 3b$, it follows that v should be proportional to b. The mean value of v/b for thirty liquids is 1·20, the deviations not exceeding 10 per cent. Since $v = M/d$, where M is the molecular weight and d the specific gravity of the liquid at the boiling-point, and since also, according to van der Waals' theory, the critical temperature, θ, is given by $8/27 . a/bR$ and the critical pressure, π, by $a/27b^2$, it follows that $\theta/\pi = 0{\cdot}1176 . M/d$, so that the critical coefficient, θ/π, can be calculated from the molecular volume of the liquid at the boiling-point. With many organic liquids the molecular volumes can be calculated additively from the volumes of the constituent atoms, and the critical coefficient of a substance can hence be calculated from its molecular formula. If a substance at the critical point has the molecular weight, not M, but $\alpha . M$ owing to polymerisation, and if this degree of polymerisation is invariable, the specific volume at the boiling-point is $\alpha M/d$, and therefore $b : \alpha M/d = 1{\cdot}2$ or $b : \mu/d = 1{\cdot}2\alpha$. If the quotient $b : M/d$ is greater than 1·2, α is greater than 1 and the liquid is polymerised, as is the case with water, alcohols, thiophene, etc. But for most substances the quotient $b : M/d$ is equal to 1·2, which is in agreement with Guye's result that, at the critical point, the molecular weight is the same as in the gaseous state. T. H. P.

738. *Equivalent Conductivity and Ionisation of Nitrites.* **P. C. Rây** and **N. Dhar.** (Chem. Soc., Journ. 103. pp. 10–18, Jan., 1913.)—The authors have determined the equivalent conductivities at 20° for varying dilutions of the following nitrites. The equivalent conductivities at infinite dilution are given in brackets. The nitrites of ammonium (126·3), lithium (93·7), sodium (104·3), calcium (112·9), strontium (113), barium (116·75), magnesium (106·9), zinc (108·1), silver (115·2), tetramethylammonium (99·2), phenyldimethylethylammonium (85·4), *iso*butylammonium (91·3), butylammonium (91·3), allylammonium (94), dipropylammonium (82·9), propylammonium (95·4), tripropylammonium (78·2), diethylammonium (88·7), triethylammonium (105·2), nickel (94·0), and copper (106·8); also of sodium mercurinitrite, tetramethylammonium mercurinitrite and mercurosomercuric nitrite. In no case was the max. value of the equivalent conductivity observed directly, owing to hydrolysis. The results show that the amine nitrites behave like typical ionogens, and are similar to alkali and alkaline earth nitrites. [Compare Abstract No. 1596 (1912).] T. S. P.

739. *Dissocation Pressures and Melting-points of the System Copper-Cuprous Oxide.* **R. E. Slade** and **F. D. Farrow.** (Roy. Soc., Proc. Ser. A. 87. pp. 524–534, Dec. 13, 1912.)—Investigation of the melting-points of mixtures of copper and cuprous oxide shows that the system is similar to that of phenol and water. The melting-point of the pure oxide is about 1210°. At temperatures above 1195° mixtures having a composition between 20 and 95 per cent. of cuprous oxide separate into two layers. Up to 1400° there is only a slight narrowing of this range of concentration, so that rise of temperature causes only a small increase in the solubility of one liquid phase in the other. The dissociation pressures were determined with the aid of the electric furnace devised by Slade [see Abstract No. 687 (1913)], and the pressures of oxygen measured are given in the form of curves showing their dependence on the time. The dissociation pressure over the fused mixture of metal and oxide is 4 mm. at 1205°, 10 mm. at 1240°, 12 mm. at 1260°, and 25 mm. at 1324°. Calculation of the heat of dissociation by means of van't Hoff's formula gives the value — 90,060 gm. cals. at 1205–1260° and — 55,890 gm. cals. at 1260–1324°, the value for the dissociation of solid cuprous oxide at the ordinary temperature into oxygen and solid copper being — 81,600 gm. cals. The value is hence not independent of the temperature, and this is what would be expected if the composition of the two liquid phases changed with the temperature; that this actually occurs is indicated by the results obtained. T. H. P.

740. *Mode of Ionisation of Sulphuric Acid in Dilute Aqueous Solution.* **J. A. Muller.** (Comptes Rendus, 155. pp. 1499–1502, Dec. 23, 1912.)—Electrolytic dissociation of sulphuric acid may give either SO_4'' or HSO_4'. In the latter case, the law of mass action gives for very dilute solutions $\alpha^2/v(1-\alpha)=K_\infty$, where α is the degree of dissociation for the molecular solution volume v and K_∞ is the equilibrium constant at infinite dilution. The dissociation constant changes with the volume, so that $K_v=f(v)$. The author finds that—

$$(K_v-K_\infty)/(v+\mu)=\lambda,$$

where μ and λ are constants. The dependency of K_∞ on the temperature is expressed by $ln K_\infty = 28{\cdot}8722 - 0{\cdot}189883T + 0{\cdot}00026633T^2$, whence—

$$dln K_\infty/dT = 0{\cdot}00053266T - 0{\cdot}18988.$$

T. H. P.